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Technology Branch

Direction Technologie

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Centre de
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Transports
Canada

Sept. 1977

Sept. 1977

CA1
T210
P62

© Department of Supply and Services
Catalogue No. T48-17/1977
ISBN: 0662-01199-6

Egalement disponible en
français sous le titre
"Répertoire des Projets"
No. de catalogue T48-17/1977F



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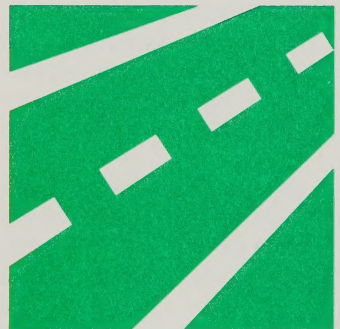
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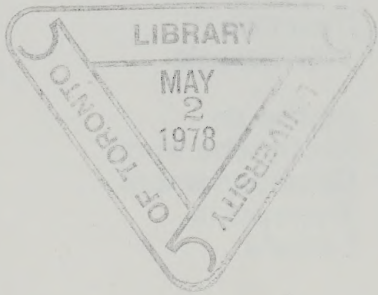
Direction Technologie

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Transports
Canada

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Foreword



This is the first of a planned series of annual 'Project Directory' publications which describe the projects of the Technology Branch of the Transport Canada Research and Development Centre (TDC). This volume covers significant projects completed in recent years as well as selected projects active as of March 1977. Future volumes will describe current and new work undertaken in the reporting period. Taken together, the successive volumes will serve as a record and ready directory to the principal activities of the TDC Technology Branch.

The 'Project Directory' is organised in sections according to the thrust areas of the Branch's research and development program:

- Railway Technology
- Surface Technology
- Air Technology
- Marine Technology

Each section stands alone with its own table of contents. The sections are further sub-divided into subject categories with background descriptions and explanations. Individual project descriptions contain the nature, scope and status of the activity, pertinent project data, reports that have been prepared and the name of the organisation performing the work. Where convenient, photographs are used to supplement the project descriptions.

The preparation of this 'Project Directory' was, itself, a project of the Advanced Technology Division. The principal contributors in the assembly of the publication were:

- Mrs. Terry K. Gillies - Editing
- N.E. Rudback - Advanced Technology Division
- W. McLaren - Current Technology Division
- M.E. Brenckmann - Technology Applications Division
- TDC Publications Section

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Preface

This publication contains descriptions of selected current and recently completed Research and Development projects supported by the Technology Branch of the Transport Canada Research and Development Centre (TDC).

The Technology Branch identifies and investigates technological factors and developments which will promote a more effective and efficient Canadian transportation system. The Technology Branch's program includes research, development, test and evaluation projects ranging from the conceptual, through prototype, to revenue demonstration phases as well as improvements and modifications to the technology of existing systems. The work covers all modes of transport, surface, marine and air, and is directed towards technology that is relevant to Canadian transportation needs in both an immediate and a future context.

Projects are implemented through contracts with private firms, universities, grants to public bodies, working agreements with other Federal agencies and in-house studies.

The Technology Branch organizes its work into three divisions:

- Current Technology Division
- Advanced Technology Division
- Technology Applications Division

Current Technology projects address themselves to improvements and modifications to technology currently used in existing transportation systems. The projects cover all modes with particular emphasis given to all aspects of surface transportation. The product of these projects include prototype hardware, test results and reports.

Advanced Technology projects are intended to investigate totally new concepts and innovative technical solutions that have promise for overcoming shortfalls in systems using conventional technology. All modes of transportation are addressed but emphasis is directed to the surface mode.

Technology Applications projects involve application testing and evaluation of technological developments that arise from the studies undertaken by the Current and Advanced Technology Divisions and also other relevant sources. These projects include supporting studies when needed to establish a base for

evaluation and comparison. Technology demonstration projects are directed towards introducing on an experimental basis new methods, equipment or systems for a transportation mode. This enables quantification of factors which determine customer and community acceptance, economic viability and operational performance of the innovation.

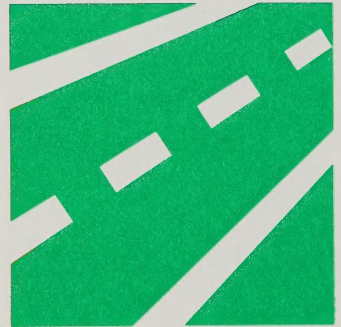
Further elaboration on the TDC structure and activities is included in the Appendices.


To facilitate access to a specific sphere of interest, projects described in this publication are grouped under modal headings. The supporting reference data adequately tie the project to the appropriate division should further information be required.

The dates listed under the "Schedule" section usually indicate the period of time from the signing of the contract to receipt of a draft of the final report. The "Funding" section represents, except when otherwise indicated, Federal money made available by TDC.

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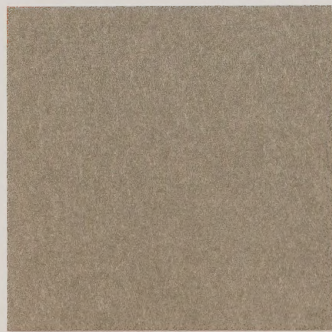
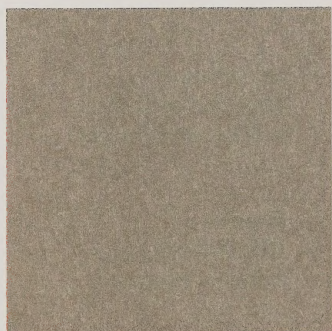




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Railway Technology



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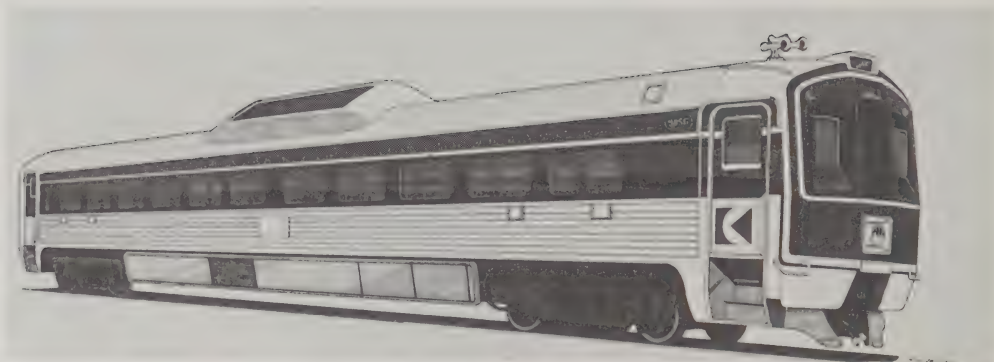
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Railway Passenger Projects

In January 1976, the Minister of Transport announced a major government commitment with respect to rail passenger services across Canada. The rail passenger policy is aimed at providing efficient and attractive services in areas where rail is an appropriate and effective form of passenger transportation. The first sector to receive attention, the densely populated Quebec City/Windsor corridor, is the subject of a demonstration project which will identify initiatives for possible application in other parts of the country. Changes in the existing roadbed, signal system, frequency, speed, and operational techniques are currently being evaluated for implementation. Existing intercity rail cars must be up-dated and new equipment acquired to provide passengers with an ambience in keeping with the times. TDC is currently supporting research and development in all these modes so as to ensure the rail mode remains a viable option for intercity passengers in Canada. The TDC activity in this area dates from 1971 and has had significant input into recent policy amendments and current commitments.

References - Guided Ground Transportation Study,
W. McLaren, B. Myers, Canadair Ltd., Information Canada
Catalogue No. T48-2/1971.

- Implementation of Rail Passenger Demonstrations,
D. Sturgess, H.A. Simons Consulting Engineers, August 1974.



*Top:
Exterior view of Budd Rail
Diesel Car proposed in the
modernization study. -
Page 5.*

*Bottom:
New Interior design proposed
for Cars in The Budd Rail
Diesel Car Modernization
Study - Page 5.*

The Budd Rail Diesel Car Modernization Study

Description

The Budd Rail Diesel Car was first built in 1949 with a major redesign in 1956. Since that time the cars have remained essentially the same. Of stainless steel construction, these cars have shown virtually no deterioration over the years. However, the propulsion system and the car interiors are of dated design, this situation has been further aggravated by General Motors stopping production of the diesel engine used.

Because of the cars wide acceptability in CP Rail and CNR service, this project was undertaken to study the feasibility and cost of rehabilitating the Budd Rail Diesel Car. The study included consideration of a gas turbine alternative power plant, modernizing the interiors and estimates of operating costs and performance data on the modified cars.

An initial task was to measure the performance of the present RDC so as to establish baseline data against which to evaluate any modification.

The structuring of the final report is such that it serves as a guide to government and railway management wishing to assess the options available concerning RDC modernization. It contains the best estimates of the capital and operating costs of:

- Modernizing the RDC's, but retaining existing diesels
- Modernizing the RDC and retrofitting with one of three

new power units:

Replacement Diesel Engine

Garrett 831-800 gas turbine

Pratt & Whitney of Canada ST6 gas turbine

- New self-propelled rail cars.

Schedule

September 1975 - March 1977

Funding

\$253,000.

Recent Progress

Project completed.

Project Number

5121

File Number

D 500-223-1

Contractor

Canadian Pacific Consulting Services Ltd.

Sub-contractor

Garrett Manufacturing of Canada Ltd.; Canadian Vickers Ltd.;
Pratt & Whitney of Canada Ltd.; National Research Council;
Bombardier-MLW, Gidman Design Associates Ltd.

Reports

- Budd RDC Modernization Study Vol. 1 to VII - CPCS



*Top Left:
Stage 1: Comparative testing
of LRC with baseline CNR
GPA-17 locomotive to estab-
lish relative wheel/rail forces
- Page 7.*



*Top Right:
Stage 2: Full performance
testing at US DOT/FRA High
Speed Test Center, Pueblo,
Colorado - Page 7.*



*Centre:
Stage 3: Evaluation of LRC
prototype equipment in daily
revenue operation on CNR
Toronto-Sarnia Tempo service
- Page 7.*

*Bottom:
Stage 4: Testing at speeds up
to 129 MPH on CPR Main line
Track - Page 7.*



LRC Prototype Testing and Evaluation

Description	<p>The acronym 'LRC' designates a passenger train concept that is intended to be 'Light, Rapid and Comfortable'. The LRC train project was initiated in 1968 by a Consortium of three Canadian companies; Alcan Canada Products Ltd., Dominion Foundries and Steel Ltd. and MLW Industries each of which brought to the endeavour its own specialized skills and experience.</p> <p>The basic concept envisaged a train of one locomotive and five cars to carry as many as 350 passengers and to meet the following criteria:</p> <ul style="list-style-type: none">- A maximum speed of 120 mph.- The ability to maintain a high average speed.- An improved comfort standard even at high speeds.- Essential compatibility with existing equipment and with current operating and maintenance procedures.- Low direct operating costs. <p>TDC supplied financial and management support for a project to test and evaluate the prototype LRC locomotive and coach having the following objectives:</p> <p>Stage 1 - To demonstrate the acceptability of the LRC to operate at conventional speeds on Canadian mainline track.</p> <p>Stage 2 - To explore the full operating limits of the prototype LRC equipment under controlled conditions.</p> <p>Stage 3 - To subject the prototype LRC equipment to daily revenue operation over an extended period (in CNR Tempo service).</p> <p>Stage 4 - To demonstrate the acceptability of the LRC to operate in excess of conventional speed limits on Canadian mainline track (up to 120 mph).</p> <p>The LRC prototype was exposed to the most comprehensive and persistent railway passenger equipment testing in Canadian history. The equipment accumulated 100,000 test miles, including 20,700 miles at the US DOT/FRA High Speed Ground Test Center, Pueblo, and 65,000 miles in CNR's Toronto-Sarnia Tempo service. The project also established the basis for future testing procedures, acceptance criteria, policy considerations and enhanced Canadian experience to introduce new passenger equipment.</p>
Schedule	May 1973 - March 1976
Funding	TDC - \$1,121,508. LRC Consortium - \$250,000 (est.)
Recent Progress	Project completed (see Reports)

Project Number	5127
File Number	D 500-175-1
Contractor	MLW Industries Montreal
Reports	<ul style="list-style-type: none"> • Stage I - "Testing and evaluation of LRC Prototype Equipment Operating under Existing Mainline Limits", M.N. Wadhwani, MLW Industries "Report on Interior Design Concepts" "Comparative Ride and Tracking Test between LRC Locomotive & Class GPA-17e Passenger Unit (CN)". • Stage 2 - "Performance of the Prototype LRC Locomotive and Coach at the US DOT/FRA High Speed Ground Test Center, Pueblo, Colorado" Stage II, MLW Industries "Mainline Running of the LRC Winter Conditions from Avondale, Colorado to Hamilton, Ontario", and "Truck Inspection at Dominion Foundries and Steel Ltd., Hamilton Ontario" Report revised by: M.N. Wadhwani, MLW Industries. • Stage 3 - "Evaluation of the LRC Equipment in Daily Revenue Operation in CNR Tempo Service, March 1975 to November 1975", Stage III. Report prepared by M.N. Wadhwani, MLW Industries. • Stage 4 - Preliminary testing for this stage was undertaken as an element of Department of Industry, Trade & Commerce PAIT Project No. L8803 (which supported 50 percent of costs of design, prototype manufacture and initial testing). The test results are contained in the IT & C PAIT project report "Manufacture and Initial Testing of the LRC High Speed Passenger Train". • Evaluation of Equipment Testing Experience, A.H. Paton, Bombardier-MLW, 1977.

Technology in Passenger Transportation

Description	<p>Transport Canada, recognizing the need for coherent planning of passenger transportation in Canada, commissioned detailed studies into five diverse sectors; air, bus, car, ferry and rail.</p> <p>The rail study describes the present state of technology in Canada against a background of technology in actual world-wide service. The report includes not only passenger service rolling stock, but also the railway lines, terminals, passenger services, operating methods, regulations, procedures and any other factor thought to have impact on productivity. The conclusions reached in this study provide guidance for much of the current development in passenger service.</p>
Schedule	December 1974 - April 1975
Funding	\$41,199.
Recent Progress	Project completed.
Project Number	5061
File Number	D 500-5-3 (Ref. D105-5)
Contractor	Queen's University CIGGT
Reports	<ul style="list-style-type: none">• A Survey of Rail Passenger Transportation, CIGGT - March 1975. (Part of the National Transportation Study).• Technology and Productivity in Passenger Transportation, TDC-Sept. 1975.• Technologie et Productivité du Transport de Passagers, CTD, sept. 1975.

Rail Corridor Market Survey and Assessment

Description

Marketing activities of this project are related to the development of improved rail passenger service in the Quebec-Windsor corridor. In order to estimate the potential share that the rail mode can expect to attract from the travelling market it was necessary to assess why people do or do not ride trains and to develop traffic forecasting tools. The process of establishing this marketing model was divided into two phases: a qualitative phase to identify service attributes important to people's choice of a particular mode of transportation; and a quantitative phase to survey travellers (by interview) on the Montreal-Quebec and Toronto-Windsor sections of the corridor. A computer model will be developed so as to relate the data gathered on historical travel behaviour and on perceived performance of the various modes to an individual's actual modal choice.

Having identified these factors and collected sufficiently reliable data to develop the computer model, it should be possible, by simulation, to predict the effects of various improvements to levels-of-service on modal share.

Schedule

January 1976 - November 1976

Funding

Contract 5140, \$78,000.
Contract 5139, \$20,831.

Recent Progress

A computerized market simulation model was released to the railways and has been used by them (under contract to Transport Canada) for developing plans for the Montreal/Quebec route (CP) and Toronto/Windsor (CN) route. In-house TDC activity is continuing: refining the initial model, and investigating its applicability to others corridor routes.

Project Number

5139/5140

File Number

D 500-209-3

Contractors

Bruce Mallen & Associates Inc.
Market Facts of Canada Ltd.

Reports

- Report on Qualitative Research to Determine Transportation Service Attributes which Influence Travellers' Mode Decisions, Bruce Mallen & Assoc. Inc. - February 1976.
- A Method of Quantifying Travellers' Value for the Design of Optimal Inter-City Transportation Systems, Market Facts of Canada Limited. (In final preparation).

Data Collection & Handling System for High Speed Track Structure

Description

With the advent of high-speed passenger trains, an organized method of accumulating data on their impact on the track-structure is needed.

This project is intended to define a data collection and handling system for monitoring the performance of the track structure in the high-speed section of the Montreal-Quebec Improved Rail Passenger Service Demonstration over an extended period of time.

The Investigators will not only identify the type of data to be collected together with the type of instrumentation necessary but also make recommendations as to recording equipment, frequency of data acquisition and manpower requirements.

Schedule

November 1976 - March 1977

Funding

\$5,000.

Recent Progress

Final report is being drafted

Project Number

6287

File Number

D 500-362-1

Contractor

Portland Cement Association
Skokie Illinois

Reports

- Data Collection & Handling System for High Speed Track Structure, A. Hanna, Portland Cement Association, 1977.

Track/Train Dynamics Research

Perhaps the most prolific program of rail research in North America is in the area of Track/Train Dynamics - the study of how a rolling train interacts dynamically with the track which supports and guides it.

Early in 1972 the Association of American Railroads (AAR) formulated a 10-year plan for study in the area of Track/Train Dynamics. TDC co-operates with the AAR so as to ensure that research carried out by Canadian and US government agencies, independent associations and private companies is co-ordinated to provide for the most efficient use of the resources available to address the more universal aspects of this problem.

The objectives of this program are to develop a better understanding of Track/Train Dynamics so as to improve criteria for train handling characteristics; to develop effective standards for track and equipment so as to meet the higher demands of increased speed, heavier trains and intermodal competition; and to redesign critical components of track structure, locomotives and rolling stock to meet the future needs of rail systems.

In Canada the growth of rail freight traffic and the trend to higher axleloads and increased speed has produced serious problems for railroads in the disproportionate increase in maintenance costs due to equipment and track deterioration. Derailments have increased, particularly with heavy unit trains used for carrying bulk commodities, resulting in operating constraints in a market where such restrictions are extremely costly.

The Canadian Track/Train Dynamics program, supported jointly by the CNR, CP Rail and TDC undertakes research aimed at alleviating these problems.



Nipigon Bridge used as a test bed for CP Rail research into structural displacement under dynamic loads. Laser technology enabled measurement of vertical and lateral displacement in the order of 0.005 inches. - Page 17.

Track Structure Test Facility at the CN Rail Technical Research Centre, Dorval Quebec. Loaded cars are cycled over the track to simulate gross tonnage. - Page 15.



Track/Train Dynamics Research, CNR

Description

The current project in the Track/Train Dynamics program with CNR is designed to evaluate and to continue the work of preceeding phases

The major accomplishments of completed projects included the development of an articulated freight car truck; redesign of 6-axle locomotive truck structures so as to reduce lateral curving forces; the development and field testing of fully instrumented wheel-sets with associated telemetry equipment for freight cars; the identification of a new wheel profile to reduce rail and wheel wear; and a series of tests conducted on a new CNR track structure test facility.

This project will make use of the track structure test facility to continue studies on the strength of steel-reinforced concrete ties and their maintenance and reliability characteristics. Field trials will evaluate elements developed in the preceeding phases, the articulated freight car trucks, the modified 6-axle locomotive trucks, the new profile wheels and the instrumented wheel sets.

The track infrastructure will be carefully reviewed with close attention given to the physical characteristics of the ballast material.

Particular emphasis will be put on the development of train handling recorders to provide data for the development of improved train handling procedures and for program input to simulators used for locomotive crew training.

Schedule

April 1976 - March 1977

Funding

TDC - \$288,000.

CN - \$288,000.

This program is funded annually, the amount shown represents funding for FY 76/77.

Recent Progress

Final report being drafted.

Project Number

6229

File Number

D 500-168-3

Contractor

Canadian National Railway

Reports

- Tests on BC South Line, Clearwater Subdivision (to establish cause of rail wear in curves with the use of 100-ton capacity vehicles) CNR - 1975.
- Wheel Set Calibration, R. Connolly and J.W. McDonald, CNR - 1975
- Test Report on the Comparative Performance of Freight Car Trucks on Special Wheel Profiles, CNR - 1975
- Wheel Profile Test on Luscar Coal Service Gondoles, CNR - 1975
- Displacement of Newly Constructed Concrete Tie Track Under Static Lateral Loads, J.F. Scott, CNR - 1975
- Lateral Strength Evaluations of Conventional Track Fastening System, J.R. Lundgren and J.F. Scott, CNR - 1975
- Preliminary Evaluation of Locotrol in Unit Train Service on Mountain Region, CNR - 1976
- Photographic Study of Ballast, J. Berard, CNR - 1976
- Rail Replacement Costs on B.C. Southline, CNR - 1976
- Effect of 100-ton Carloadings on Train Accident Costs, CNR - 1976
- Wheel Profile Test, Luscar Coal Service Gondola, Progress Report No. 2, CNR - June 1976
- Wheel Profile Test, Luscar Coal Service Gondola, Progress Report No. 3, CNR - January 1977
- Direct Shear Test on Selected Ballast Samples, CNR - March 1977
- Evaluation of the Performance of Concrete Tie Structures. Report in preparation, not yet published.
- Development of Instrumented Freight and Locomotives Wheels. Report in preparation, not yet published.
- Modifications to 3-axle Locomotives to Reduce Lateral Curving Forces. Report in preparation, not yet published.

Track/Train Dynamics Research, CP Rail

Description	The program of Track/Train Dynamics with CP Rail is intended to identify improved rail metallurgy characteristics, investigate the nature and magnitude of rail wear under heavy traffic conditions, prepare a theoretical model for the study of dynamic effects of unsprung weight on track-structures; develop instrumentation using laser techniques to measure wheelset angle-of-attack through curves and to collect comparative data on the steering characteristics of several truck designs.
Schedule	March 1975 - March 1978
Funding	TDC - \$190,400. CP Rail - \$190,400.
Recent Progress	See reports
Project Number	5028
File Number	D 500-168-4
Contractor	Canadian Pacific Ltd.
Reports	<ul style="list-style-type: none">• Photographic Study of Ballast, J. Berard, CPCS - 1973• Natural Frequencies of Vibrations, Heavy Freight Cars, CPCS - 1974• Testing of 100-Ton Bathtub Coal Cars Equipped with Hydraulic Interbogie Coupling Devices. Progress Reports 3 and 3A, CPCS - 1974.• Rail Wear Under Heavy Traffic Conditions, J.K. Kalousek and A.E. Bethune, CPCS - 1975• Rail Metallurgy, J. Kalousek and G. Benyhon, Report No. S497-75, CPCS - 1975• Measurements of Bridge Pier Displacement Using Laser Technology, J. Kalousek and R. Gonsalves, Report No. S491-75, CPCS - 1975• Rail Corrugations, J. Kalousek Report No. S488-75, CPCS - 1976

Rail Metallurgy Development

Description	<p>Rail wear has accelerated and changed in nature with the introduction of heavier axle loads and with increased traffic. This project is part of an on-going rail research program to resolve the problems arising from these heavy wear conditions.</p> <p>Recent studies on rail corrugation, which is one manifestation of the "new" wear phenomenon, reveal that rail life is governed by a complex interrelationship between wheel/rail contact geometry, lubrication, surface fatigue, endurance of rail steel and rail metallurgy. A review of current rail metallurgy led to the formulation of this project.</p> <p>The project is intended to develop, produce, install and test chrome-molybdenum steel rails. A 100-ton heat of Cr-Mo alloy steel has been produced and rails made from this heat will be subjected to metallurgical and physical testing. A survey of European production methods will be made to assist in developing production techniques for this alloy.</p> <p>When development of rail production techniques enables rail production for in-track evaluation, investigators will review the effects of the Cr-Mo on tooling currently used in field repairs and rail-end reclamation by welding.</p>
Schedule	October 1975 - March 1978
Funding	\$73,150.
Recent Progress	See Reports below
Project Number	5122
File Number	D 500-259-1
Contractor	Canadian Pacific Ltd.
Sub-contractor	Algoma Steel
Reports	<ul style="list-style-type: none">• Evaluation of Algoma Chrome-Moly Rails. Interim Experimental Results, Algoma Steel - 1975• Visit to European Rail Producers to discuss alloy rail production.

Dynamic Measurements in the Study of Corrugated Rail

Description	<p>To date no proof exists as to the mechanism of the formation of rail corrugation on rails in heavy service conditions. Of the several theories advances two seem most likely:</p> <ol style="list-style-type: none">1. That, in curves, the contact point undergoes a slip-stick cycle due to saturation of the creep characteristics caused either by a high angle-of-attack of the wheel to rail or wind-up of the axle or both.2. That oscillatory dynamic loading is excited at the rail-wheel interface by the natural dynamics of the rail vehicle system. <p>This project, using dynamic measurements to study rail corrugations, has provided useful new evidence against which to test hypotheses of the cause of this complex engineering problem. Specifically, measurements were taken to accumulate information on the detection of slip-stick and of normal (vertical) forces. The tests were conducted using 100 ton bulk cars over sections chosen to represent a variety of curvatures and conditions including new track.</p>
Schedule	March 1976 - December 1976
Funding	TDC - \$8,000. NRC - \$18,000.
Recent Progress	Project completed.
Project Number	5169
File Number	D 500-168-6
Contractor	National Research Council
Reports	• Dynamic Movement of a Heavy Car Wheelset over Rails Subject to Corrugation, F.B. Blader, NRC.

Railway Track Structure Research

Description	<p>A program at Queen's University under the aegis of the Canadian Institute of Guided Ground Transport was started in 1974 to undertake studies aimed at improving railway track structure. The purpose of the current project is to address track structure improvement through better selection of ballast material and through the sizing and spacing of rail ties. Investigators will conduct tri-axial testing of ballast material supplied from CPR and CNR aimed at identifying an improved grading specification directly applicable to Canadian ballast materials. Research will also identify the tie/ballast contact pressure distribution for ties so as to optimize the shape of the tie.</p> <p>A three-dimensional finite-element model will be used to develop a computer program to predict the extent of permanent settlement in the ballast bed as a function of loading and ballast properties.</p>
Schedule	May 1976 - April 1977
Funding	<p>TDC - \$40,533.</p> <p>This represents one-third of the total funding. CNR and CP Rail share the remaining two-thirds.</p>
Recent Progress	Static tests on several ballast samples complete. Model tests on 7" diameter footings underway.
Project Number	6256
File Number	D 500-372-1
Contractor	Queen's University - Canadian Institute of Guided Ground Transport.
Reports	<ul style="list-style-type: none">• A study of Stresses and Deformations under Dynamic and Static Load Systems in Track Structure and Support, G.R. Raymond, CIGGT Reports No. 76-11, and 75-10.

Railway Terminal Projects

Railway cars spend 84 percent of their time in terminal locations. If this figure could be reduced by even a few percent significant benefits would accrue in terms of improved operating efficiency to the railways and faster shipment of goods to rail transport users. In order to effect increased terminal capacity and efficiency it has generally been accepted that terminal facilities must be expanded through the addition of classification tracks and other new physical plant. The increasing costs of plant expansion, particularly in metropolitan areas, has led to a search for other solutions to the rail terminal congestion problem.

The TDC efforts in this field have centered on the support of railway efforts to develop computerized systems for the control and management of railcars in terminal areas. One project, with CNR, for a hump yard (Montreal) developed a system to interface with Automatic Car Identification equipment primarily to enable more efficient maintenance of car inventory. Another project, with CPR, for a flat yard (Vancouver) placed greater emphasis the elimination of all routine manual paperwork functions in the yard office and on incorporating management information features, thus providing comprehensive automation of yard operation.



*Top:
CP Rail's Vancouver Terminal
site of YARDS Project. -
Page 25.*

*Right:
CRT Display used as Computer
Assist to CP Rail personnel in
Vancouver Terminal. -
Page 25.*



Vancouver "YARDS" Project

Description

CP Rail has been working to develop more effective systems for terminal control since the late 1960's. In 1972 a serious effort was made to explore the use of computer techniques in this field. The result of this research was the conceptual design and functional description of "YARDS" a Yard Activity Reporting and Decision System.

The purpose of the current project is to develop, implement and evaluate the computerized management information and control system in the Vancouver rail terminal complex of CP Rail. The design will be sufficiently flexible that it can be adapted to other terminals of CPR and also have potential for application to other Canadian railways. It is intended that the system have the capability of expanding in the future to interface with remote inputs from customer locations and to interconnect with other systems used for Vancouver area traffic management.

When implemented YARDS will significantly change the present manual method of rail yard operation. The major routine record keeping and reporting functions will be automated, resulting in a reduced clerical work load and leading to a significant reduction in clerical staff. Through more rapid preparation and remote printout of switch lists and other operating instructions, the efficiency of yard engine utilization will be improved. It is expected that the faster processing of documents associated with car movements, plus the management information and control features being incorporated, will produce a 5 percent reduction in the average car time spent in the terminal.

YARDS is modular in concept and consists of the user interface (CRT and printers), communications lines and the computing facility. The system uses some 30 CRTs and 25 printers as remote terminals to communicate with the AMDAHL 470 computer. It is expected that this design approach will facilitate future expansion of the system and permit ready transfer of the concept to other large terminals.

Schedule

February 1976 - March 1978

Funding

TDC - \$500,000.
CP Rail - \$1,500,000.

Recent Progress

Computer programs have been prepared and are being tested. Training of operating personnel at Vancouver has started. Phase I implementation (basic functions) is expected in May 1977, with the system to be fully operational in late 1977.

Project Number

5022

File Number

D 500-274-1

Contractor

Canadian Pacific Limited

Reports

- Canadian Pacific Yards Project Functional Specification, CP Information Services.
- Canadian Pacific Yards Project System Specification, CP Information Services.
- Canadian Pacific Yards Project Programming Specification, CP Information Services.
- Automatic Car Identification System CNR, P. Hoisak.*
- Yard Computerized Inventory System CNR, P. Hoisak.*
 - * Reports from CNR humpyard project

Vancouver Rail Terminal Performance Evaluation

Description

In support of the Vancouver YARDS Project a method must be evolved to evaluate terminal performance "before" and "after" the introduction of the YARDS system. This evaluation will serve to quantify the system benefits so as to provide a basis for establishing similar systems in other rail terminals.

Investigators intend to use as a major criterion for terminal performance evaluation the car cycle time measured in terms of the average and standard deviation; the analysis will be based on this time. Data for analysis will be accumulated for the years from 1972 to one year after the implementation of YARDS. This time span is considered necessary in order to isolate improvement produced by the computer system from the impact on the Vancouver operations of other factors such as new track construction, demand for commodity movements, congestion of the terminal etc.

Schedule

September 1975 - March 1978

Funding

In-house activity: 2 man-years

Recent Progress

Accumulation of data is underway

Project Number

5022

File Number

D 500-242-2

Contractor

TDC

Reports

None to date.

Feasibility Study for Vancouver Terminal Area Railcar Information System

Description

Investigators for this project will undertake a study to identify the requirements for, and determine the feasibility of, a dynamic mechanized railcar information system in the Vancouver terminal area.

The type of system envisaged would interconnect with CP "YARDS", CNR and BC Rail and could conceivably be extended to monitor and control intermodal commodity traffic into and out of the Vancouver area.

It is intended to first describe the static information system now in use with all its attendant shortcomings. A conceptual definition will then be developed for a mechanized information system capable of accommodating the task of the present manual system and extending the static railcar inventory information to dynamic car delivery forecasts. Investigators will identify potential users and the specific benefits accruing to each category of user.

Schedule

November 1976 - May 1977

Funding

\$5,000.

Recent Progress

Potential users have been interviewed.

Project Number

6305

File Number

D 500-242-1

Contractor

H.A. Simons (International) Ltd.

Reports

None to date.

Railway/Roadway Level Crossing Research

The planned introduction of high speed, 95 to 125 mph, passenger trains in the Toronto-London-Windsor and the Montreal-Quebec corridors has highlighted the need to determine if the increased speed has an impact on safety features currently in use at level crossings. In October of 1975 as part of a High Speed Passenger Rail Demonstration program an investigation was undertaken to define the requirements for highway crossing protection necessary to maintain current safety standards with the advent of the high speed equipment. Crossing considerations would be defined for speeds up to 95 mph and from 95 to 125 mph with emphasis placed on alternatives to grade separation techniques. Preliminary to this investigation was the development of an inventory with detailed descriptions of every level crossing in these corridors. This inventory formed the basis for many of the investigations underway at the present time.

References:

- Requirements for Highway Crossing Protection for High Speed Train Operations, J.L. Taylor CPCS - December 1975.
- Corridor Improvement Program Montreal/Quebec
- Computer Model to Study Derailment in Railway Grade Crossing Collisions, Endev - November 1976.



TOP:
Railway Level Crossing Showing
Pattern of Snow Plowing Across
Track - Page 31.

RIGHT:
Typical CNR Protected Level
Crossing, Lights - No Barriers.
- Page 30.



Level Crossings Obstruction Protection & Train Warning System

Description	<p>The purpose of this project is firstly: to define concepts for a railway level crossing protection system which not only detects the presence of an obstruction within the clearance limits of the railway crossing but also warns approaching trains of this fact and secondly: to determine the impact of such a device on the operation of a railway. Stopping a high speed passenger train or a heavy freight unnecessarily is a complex and potentially costly operation, conversely closing level crossings to road traffic for extended periods is equally unreasonable. The detection system developed should be compatible as far as possible with standard protection elements and their current applications to Canadian railway level crossings.</p> <p>The study will evaluate the impact of such a system on railway operations i.e. degree of train breaking, maintenance, scheduling etc. so as to identify any possible operating constraints. A preliminary step to this project will be a detailed analysis of available data from several sources on railway crossing accidents across Canada.</p>
Schedule	November 1976 - July 1977
Funding	\$60,325.
Recent Progress	A detailed report of mishaps on CP Rail involving stalled vehicles at crossings is being compiled.
Project Number	6280
File Number	D 500-345-1
Contractor	Canadian Pacific Consulting Services Limited
Reports	None to date.

Railway Locomotive and Car Design for Improved Safety in Level Crossings

Description

With the aim of reducing the severity of train/road-vehicle collisions this project will address locomotive frontal design and rail car structural design. There is some evidence to indicate that fatalities increase sharply when the collision speed exceeds 45 mph. Investigators will research locomotive lead-end energy absorbing devices so as to effect an impact speed reduction to 45 mph. The interior design of locomotives will also be reviewed from the standpoint of crew protection.

Although frontal collisions are most common, some accidents occur when a road vehicle hits the side of a passing train. The design of rail passenger cars will be reviewed for resistance to side intrusion. The first phase of this project will develop a data base of collision details so as to identify specific areas for protection improvement development and design.

Schedule

January 1977 - March 1977

Funding

\$5,000.

Recent Progress

Final report is being drafted.

Project Number

6349

File Number

D 500-388-1

Contractor

Dilworth, Secord, Meagher & Assoc. Ltd.

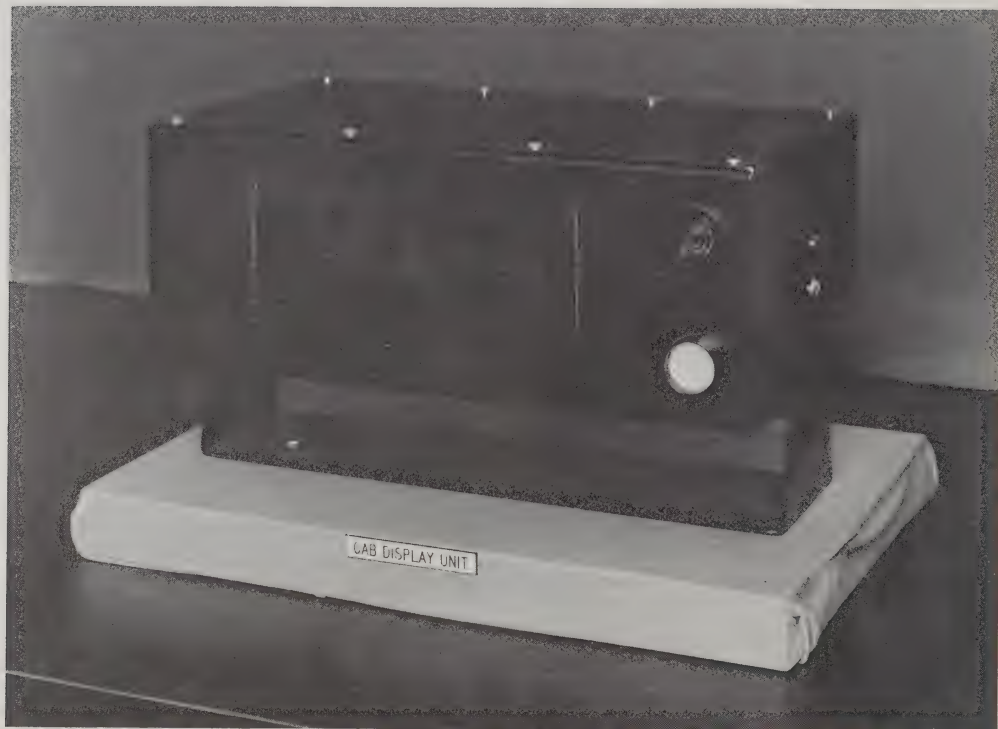
Reports

None to date.

Effect of Winter Conditions on the Safety of High Speed Trains

Description	<p>The Montreal-Quebec portion of the Quebec-Windsor rail corridor, on which high speed passenger train service is planned, is unique in that it has winter conditions more severe than on any other route on which a similar service is operated. The potential effects of these conditions on the safety of trains were thought to be significant and this project addressed investigations in that area. Specifically the objectives of the project were:</p> <ul style="list-style-type: none">- to identify winter conditions affecting the safety of high speed train operations in the Montreal-Quebec section of the Quebec-Windsor corridor. (Such conditions included frost heaving of track, snow drifting, the accumulation of snow and ice and reduction of visibility at road crossing.) and- to propose solutions, or a program of studies to reach solutions of the problems identified, compatible with the proposed schedule for implementing high speed service. <p>The study took into account all conditions caused by winter climate, geotechnical factors and related track maintenance operations which would affect the safety of high speed train operations. It did not include consideration of winter conditions which may delay or halt train operations without affecting their safety. Nor did it consider the effect of winter conditions on the mechanical operation of high speed trains.</p>
Schedule	February 1977 - June 1977
Funding	\$5,000.
Recent Progress	Project completed.
Project Number	6338
File Number	D 500-381-1
Contractor	F. L. Peckover
Reports	<ul style="list-style-type: none">• Effect of Winter Conditions on the Safety of High Speed Trains on the Montreal-Quebec Line, F.L. Peckover - 1977.

Signalling, Communications and Control Projects



Prototype Cab Display Unit Used in the Location, Identification and Control (LIC) System currently under development by BC Rail and Glenayre Electronics - Page 35.

Radio-Linked Train Location, Identification & Control

Description

B.C. Rail, which for the past four years has worked closely with Glenayre in developing the LIC system, is participating with TDC in a project to further development of a radio-link Location, Identification and Control (LIC) system of railway signaling. During the course of the project, both CNR and CP Rail, as members of a steering committee, will make their signaling experience available to Glenayre in helping to ensure the system will meet general railway requirements.

The LIC system provides the dispatcher with continuous real time monitoring of the location of individual trains and is a much more economical signaling method than the centralized train control (CTC) now commonly used on main line track. It has good potential for reducing headways and thereby increasing track capacity on new lines and on the many sections of Canadian track not now equipped with CTC signaling.

Although development is concentrating on intercity rail routes, possibilities exist for urban light rail, subway and other shorter headway applications.

The system comprises five main elements:

- locomotive electronics unit containing identification and control logic;
- transponders installed between the rails at regular one mile intervals;
- communications link between the locomotive and dispatch centre;
- a computer for storing and processing track data and train movement information;
- dispatcher interface (mimic plotboard and cathode ray tube (CRT)).

The current project is intended to demonstrate the feasibility of the system with follow-on projects planned for prototype system implementation and evaluation.

Schedule

February 1975 - March 1977

Funding

\$184,670.

Recent Progress

Project complete. Final report being drafted.

Project Number

5064

File Number

D 500-234

Contractor

Glenayre Electronics Ltd.

Reports

None to date.

Inductive Coupling for Transmission of Brake Signals in Long Freight Trains

Description	<p>Pneumatic brake lines used on freight trains have long propagation delays. These delays vary directly as the train length resulting in severe deterioration of the braking performance and handling characteristics for long freight trains (over 45 cars). The limited braking effort control of pneumatic brakes also contributes to the operational deterioration. Electrically activated pneumatic brakes could overcome these shortcomings but a simple, economic and rugged connector is needed for the control line.</p> <p>This project is intended to develop such a connector which will enable electrical activation of pneumatic brakes on individual cars along the train and which could also be used for transmission of voice and control signals between different points along the train. The connector identified for development is an inductively-coupled type.</p>
Schedule	October 1975 - March 1977
Funding	TDC - \$7,250. CNR - \$7,250. CP Rail - \$7,250.
Recent Progress	A draft of the final report "An Inductively Coupled Power Transmission System for Long Trains" has been submitted.
Project Number	5166
File Number	D 500-279-1
Contractor	Queen's University.
Reports	<ul style="list-style-type: none">• Communications System for Long Trains, GJM Aitken, CIGGT - 1975 (TDC Project 5005)• Communications System for Long Trains, Executive Summary GJM Aitken, CIGGT - 1975.

Computer Aided Train Dispatch System

Description

The railroad industry has been moving towards centralized traffic control for many years in order to improve the efficiency and cost effectiveness of their signaling systems. The use of minicomputers in such a system offers significant advantages over relay logic which has been used extensively to date. A computer assisted system leads towards automated train dispatching whereby the routine dispatcher instructions are programmed into the computer leaving the dispatcher with more time for planning and decision making activities.

The objective of the overall program is to develop a centralized traffic control system having comprehensive automatic dispatching features. The current project addresses the system definition and consists of the preparation of detailed specifications for both hardware and software of an automated train dispatching system. Investigators will also study future Canadian centralized traffic control plans and requirements and the market potential for new electronic systems.

Schedule

January 1977 - June 1977

Funding

\$120,920.

Recent Progress

System functions including the role and duties of a train dispatcher have been analysed and defined.

Project Number

6315

File Number

D 500-354-1

Contractor

Canadian Pacific Consulting Services

Sub-contractor

MPB Technologies Inc.

Reports

None to date.

Railway Infrastructure and System Studies



Top:
View of CNR's Montreal Yard

Right:
A general view of the terrain and roadbed in permafrost areas. The subsidence of the roadbed is the problem addressed in TDC's permafrost melting research - Page 46.



Canadian Railway Electrification Study

Description

This study was intended as a critical review of the prospects for the railway electrification in Canada and to identify the research and development initiatives which would have to precede such a change of technology.

In the final report a review of numerous technical and economic factors is presented, including an evaluation of the time frame in which it might be expected that electrification of significant portions of Canadian railways is likely to occur.

Technical solutions for conditions unique to Canada are available, however further investigation is necessary to identify the most acceptable and cost effective. The significance of energy costs, in absolute and relative terms, has been highlighted.

A program of investigation, research, and development designed to permit a smooth transition to effective electrified operation is outlined. One recommendation in this program is the suggestion to build a 400 mile prototype operation on existing mainline track.

Schedule

May 1975 - December 1976

Funding

\$154,125.

Recent Progress

Project completed.

Project Number

5073

File Number

D 500-249-1

Contractor

Queen's University CIGGT

Reports

- Canadian Railway Electrification Study Phase I, E.R. Corneil, R.W. Lake, C.E. Law, G.W. English, C. Schwier, CIGGT 76-2 Vol. 1 & Vol. II - 76-2; Overview 76-10.

Canadian Freight Transport Model

Description

A three phase program was started in 1971 by the Canadian Institute of Guided Ground Transport (CIGGT) to develop a computer planning model of the Canadian freight transportation system, with particular emphasis on the rail component and the effects of competition between modes. The first two phases of this program have been successfully completed and a working model of the railway network now exists. This model permits the study of transit times, capacity, congestion and other railway system characteristics under various assumptions regarding operating conditions and demand, but does not take into consideration the effects of competition from other modes. A multimodal data base has been assembled containing cross-Canada origin - destination commodity statistics organized according to a common commodity and geographic classification.

Phase III of the program, to be carried out under this contract, will address the problem of modal choice. Plausible relationships between mode characteristics and mode usage will be postulated and the form of these relationships will be estimated statistically using information contained in the data base. The purpose of this work will be to develop, calibrate and test a multimodal choice model which takes into consideration the effects of competition from trucks, ships, airlines and pipelines upon the railway system.

Schedule

November 1973 - March 1976

Funding

\$60,000.

Recent Progress

Project completed and final report has been received.

Project Number

5039

File Number

D 500-199-1

Contractor

Queen's University, CIGGT

Reports

- Freight Mode Selection in Canada, R.E. Turner, CIGGT - 1975
- Railcar Network Model, E.R. Peterson, A.V. Fullerton, CIGGT - 1975
- User Analysis Guide to the Extended Railcar Network Model, C. Schwier, T.D. Ganton, J.A. Macdonald, CIGGT - 1976

Railway Route Capacity Study

Description

Canada's railways have been experiencing increased capacity problems in specific segments of their networks. Given the predicted growth of demand, as well as expected surges due to natural resource development, significant capacity constraints are expected in the 1980's. Specific elements of this problem have been studied by various people but there has been no planned approach to the overall problem that is considered necessary to develop a useful study on railway route capacity in Canada.

This project addressed the development of a plan for a definitive study on Railway Route Capacity. The project defined methods to determine the impact of a change to an operating element on throughput and net cost. Investigators also produced a skill qualification matrix for the study together with an estimate of the resources and time required to execute the study.

Schedule

July 1975 - August 1976

Funding

\$41,144.

Recent Progress

Project completed

Project Number

5101

File Number

D 500-258-1

Contractor

Management Analysis Centre Inc.
Cambridge Mass.

Report

- Railway Capacity Trade-Off Study, Management Analysis Centre.

Arctic Railway Study

Description

The purpose of this study was to establish the engineering feasibility, cost and time required to construct an Arctic railway as a possible means of transporting oil and liquefied natural gas from the McKenzie River Delta, NWT, and Prudhoe Bay, Alaska to a point within Canada beyond the southern limit of permafrost. This study intended to raise the level of documentation on rail research to a point where reasonable comparisons can be made with pipeline proposals by deriving unit costs of transportation for a variety of volumes of gas and oil.

Existing data was re-examined to determine if sufficient attention had been paid to various environmental and soil mechanics constraints of Arctic construction. Attention was given to quantifying the extent to which Arctic conditions are likely to affect the integrity and performance of a railway system i.e. rolling stock, specialized terminals, control networks, road bed etc.

Investigators addressed the study on a modular basis.

- Railway Construction - This section defined in specific terms the extent to which the Arctic climate and topography adversely affects the construction of railways.
- Rolling Stock Design - The study team evaluated the grade/power trade-off and examined the extent to which conventional equipment will have to be modified for Arctic operation.
- Terminals - Special facilities necessary at both railway terminals were defined. The cost of liquefaction of gas was examined as well as the problems associated with loading and unloading it.
- Railway Operation - The study team evaluated the feasibility and cost of operating a railway under conditions combining 24 hour a day scheduling with unfavourable climatic and topographic conditions. Advantages to be gained from various levels of automation formed part of this evaluation.
- Arctic Constraints - Before proceeding with a full economic analysis of the cost derived from the previous sections, civil engineers and estimators familiar with the problems of operation in Arctic conditions were consulted. This ensured that the limitations of men and equipment operating under unusual conditions had been taken into account.
- Economic evaluation - Transportation cost for oil and gas were calculated based on data obtained in previous sections for several specific examples. Capital cost elements assigned to route sections, facilities and equipment were combined with operating costs appropriate to various throughput levels to establish a family of transportation cost curves.

Schedule	June 1973 - December 1975
Funding	\$1,465,389.
Recent Progress	Project completed.
Project Number	5032
File Number	D 500-188
Contractor	Canalog Consultants Ltd.
Reports	<ul style="list-style-type: none"> • Arctic Oil and Gas by Rail, Canalog Logistics Ltd - 1974 <ul style="list-style-type: none"> Vol. 1 - Introduction and Summary Vol. 2 - Route Selection and Construction Vol. 3 - Railway Operations and Maintenance Vol. 4 - Petroleum Products, Processing and Handling Vol. 5 - Relevant Considerations Vol. 6 - Cost Data Analysis

Permafrost Melting Research

Description

The purpose of this study was to gather data on the long-term melting of permafrost along the Hudson Bay Line of the CNR and to develop, through detailed ground thermal analyses, an accurate forecast of the amount of ground settlement which is likely to occur in the future. Investigations will include the assessment of remedial measures, such as berms and insulation, on the settlement.

The Hudson Bay Line has been in continuous operation since its completion in 1929. The railway passes through zones with no permafrost, zones of discontinuous permafrost and zones of continuous permafrost thus providing effective control sections for comparison measurements.

The work will be divided into two parts:

- Field Investigation to collect measurements on the various physical phenomena of the roadbed structure and sub-soil.

- Thermal Analysis: Two cross-sections will be chosen for a detailed thermal analysis using data from the field investigations and an existing computer program. As a result of the analysis estimates will be developed as to future rate of thaw, magnitude of settlements, and effect of current remedial measures.

The final report for the project will extrapolate the findings to make recommendations on maintenance and construction practices for transportation rights-of-way in regions of discontinuous permafrost.

Schedule

April 1976 - March 1977

Funding

TDC \$28,000.
CNR \$28,000.

Recent Progress

Field measurements and Thermal analysis completed.

Project Number

6209

File Number

D 500-296-1

Contractor

Canadian National Railway

Sub-Contractor

EBA Engineering Consultants Ltd.

Reports

None to date.

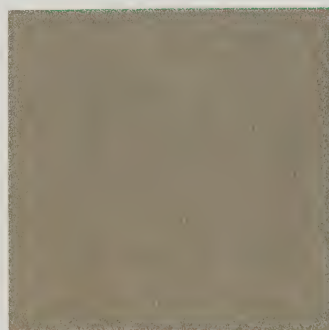
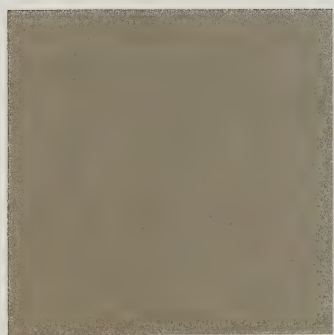
Frost Action Investigations — Phase II

Description	<p>The purpose of this project is to develop a chemical treatment which will provide an effective means of reducing maintenance costs associated with frost heaving in railway track sub-structure.</p> <p>Investigations in Phase I established the viability of surface treatments with chemicals which migrate into the soil with natural rainfall. Phase II investigations will address the problem of natural leaching reducing the residence time of the additive within the sub-soil; Investigators will monitor field test sites to study not only heave behavior but also the effect of the additive on ties and fasteners and the environment of the sub-soil.</p>
Schedule	January 1976 - June 1977
Funding	\$71,680
Recent Progress	Testing is currently underway on a method to reduce the rate of leaching by precipitation of a "void plugger" which forms an effective barrier to the frost control chemical in the upper profile of the soil.
Project Number	5024
File Number	D 500-158-1
Contractor	McGill University Office of Industrial Research
Reports	<ul style="list-style-type: none">• Alleviation of Detrimental Frost Heave With Salt Additives, N. Yong and D. Sheeran, McGill University - (4 annual reports 1973, 1974, 1975, 1976);• Alleviation of Detrimental Frost Heaving of Soils by Chemical Treatment, N. Yong and D.E. Sheeran, McGill University - 1977.

Railway Test Track Facility

Description	<p>Encouraged by favourable traffic forecasts and spurred by the need to increase efficiency, renewed emphasis is being placed on the improvement of rail technology. With the greater demands placed on the railways for increased capacity, reliability and cost-effectiveness, greater care is necessary to ensure that all design innovations are fully tested as to their impact on the complex dynamic interaction between the train and its track structure.</p> <p>Because only limited testing can be accomplished using "on-line methods" without creating serious interruption of normal railway operations an alternative method of testing is needed.</p> <p>The intent of this project is to establish this need and to fully describe a Canadian Guided Ground Transportation Test Track Facility.</p> <p>It is expected that such a facility would provide a controlled environment in which rapid test results could be produced with minimum risk and disruption to the railways.</p>
Schedule	September 1975 - December 1976
Funding	\$190,667.
Recent Progress	A draft of the final report has been received by TDC. "Canadian Guided Ground Transport Test Centre Study".
Project Number	5119
File Number	D 500-262-1
Contractor	Acres Consulting Services Ltd.
Reports	None to date.

Surface Technology



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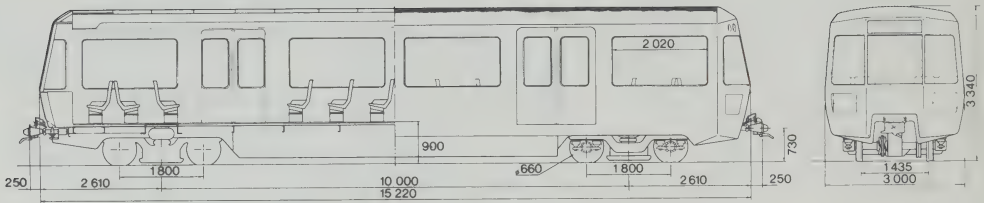
Innovative Urban Transit Technology Projects

Considerable attention has been directed toward the need for a public transit system which is intermediate in carrying capacity and cost between bus routes and a subway. Buses have a maximum carrying capacity of 4,000-6,000 persons/hour/direction which is not great enough to adequately serve the principal corridors of most cities. Furthermore, buses add to the noise, traffic congestion and pollution in a city and provide a rather slow, unattractive quality of ride.

Subways are an excellent means of urban transportation, providing rapid dependable, all weather transit with no interference to automobile or pedestrian traffic. However, subways are extremely expensive to build and their capacity level of 40,000 persons/hour/direction is much greater than generally required. Only the very largest cities have sufficient passenger volume to justify the enormous capital costs involved with subway construction.

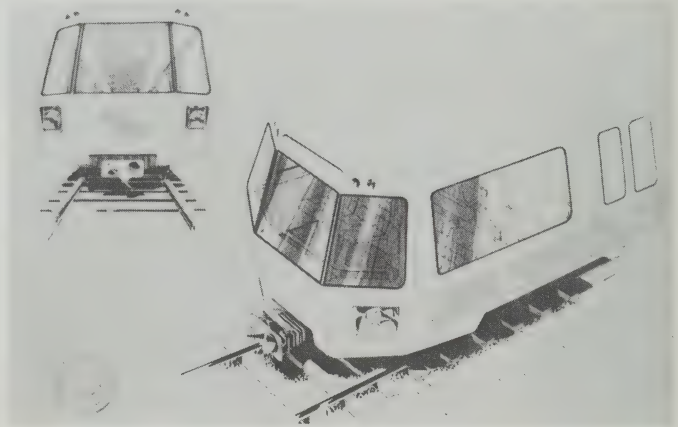
A modern rail Intermediate Capacity Transit System is intended to fill the capacity gap between buses and subways offering the promise of smooth, quiet, comfortable, safe and pollution free transportation at an economical cost. Capital expenditures are reduced through the use of lightweight vehicles operating at ground level where feasible, or on elevated guideway or underground for short stretches where necessary to avoid interference with existing surface traffic patterns. Automatic controls are utilized to provide a high frequency of service at an operating cost less than for conventional subway or bus transportation.

A great many Canadian urban transit applications fall into the middle range of demand capacity which an ICTS is designed to serve. TDC activities in the ICTS field are intended to encourage and foster the development of this technology to satisfy specific Canadian urban transportation requirements.



Top:
Dimensional drawing of Intermediate Capacity Transit Vehicle currently under review by TDC.

Centre:
Exterior view of ICTS Vehicle intended to fill the capacity gap between buses and subways in urban transportation systems. Page 53.



Bottom:
The ICTS Vehicle's interior is designed to seat 48 passengers with a crush load of 137 persons. - Page 53.



Concept Definition of an Intermediate Capacity Transit System

Description	<p>The ICTS study project will attempt to define a new type of urban transit system uniquely suited to Canadian needs.</p> <p>Four basic system characteristics have been specified within which the design must be developed. These are:</p> <ul style="list-style-type: none">- Steel wheel on rail.- Small vehicles capable of operating singly or in trains.- Electric energy source.- Fully automated design. <p>The intention is to jump beyond the light rail technology of today to produce plans for a system with smaller and less expensive vehicles which can be operated economically at frequent intervals throughout the day, even during off-peak hours. By using a standard design suitable for running on existing railway lines and rights-of-way it is hoped to bring the implementation cost down to the level where even smaller sized cities can afford this type of high quality public transit.</p> <p>The study will examine the present and expected future transit demands of Canada's 25 largest urban areas, those with populations of 100,000 persons and over. From this basic data a system design will be evolved by the contractor under the general direction of a Steering Committee consisting of senior officers from TDA, representatives from other federal government organizations, and outside transportation specialists.</p> <p>The ICTS system being addressed is intended to serve transportation needs over the intermediate term future, the decade of the 1980's and the early 1990's. Over this time frame it is believed that a system having the basic characteristics listed above, is most likely to meet Canadian requirements. Furthermore this seems to be a logical configuration which must in any event be investigated before serious consideration can be given to implementing more advanced ICTS concepts.</p> <p>No commitment has yet been made to undertake hardware development work. Should the project carry on beyond this present study stage the next steps would be detailed design followed by construction of a prototype vehicle to verify key design concepts.</p>
Schedule	September 1975 - July 1977
Funding	\$1,500,000.
Recent Progress	Final reports are being prepared but are not yet available for distribution.
Project Number	5043
File Number	D 500-208-1

Contractor	Bombardier Limitée
Subcontractors	S.A. Engins Matra Brown Boveri (Canada) Ltd. CAE Electronics Ltd. Peat, Marwick & Associates Compagnie Industrielle de Matériel de Transport (CIMT) Société de Traction CEM Oerlicon (STCO) Canalog
Reports	None published to date.

Evaluation of Urban Rail Facilities for Public Transit Applications

Description

To provide the desired capacity and meet automation objectives, intermediate capacity transit systems require exclusive rights-of-way. One possible alternative for obtaining the right-of-way and at the same time achieving low cost and rapid implementation is to make use of existing urban corridors, particularly rail alignments. This study surveys the physical and operational characteristics of existing rail lines in 13 major Canadian urban centres to determine their suitability for urban transit purposes.

The procedure used in the study was to first determine the factors which affect the use of rail alignments for public transit applications. These key factors are described in the report. The lines which were judged to have possible potential for future transit applications, (i.e. those which correspond with the desired lines of commuter travel) were identified with the assistance of urban transportation consultants. Each railway owning lines so identified was sent copies of an inventory form with instructions on its completion and, where required, was visited by the consultant to ensure understanding and a consistency of returns. The completed inventories were edited and compiled into a standard format for the final report, and the route alignments were illustrated on large scale maps.

Experience in the planning of projects involving railways and other parties, such as municipal and provincial authorities, has demonstrated that the most difficult features associated with sharing right-of-way or trackage will often not be the obvious problems of space, bridges, track conditions, etc., but in the rigorous detailed examination of train control, safety, and, most of all, the establishment of acceptable levels of mutual interference. The railway companies quite understandably resist any influence that would limit their capability to serve their customers, and hence weaken their competitive position. The conclusion drawn, therefore, is that this type of general survey can produce a guide to the relative suitability of rail lines and rights-of-way for urban transit use, but no absolute decision as to such suitability can be made without detailed analysis of specific cities and lines as part of a detailed feasibility study.

It is considered important that potential transit rights-of-way be identified so their value as a community resource be appraised before action is taken on other non-transportation use of this land. Also, it is hoped that the results of this study will be of use to municipal planning authorities by providing background data on the characteristics of this vital element of the transportation system in their communities. In addition the results should prove useful in assessing the applications for railway relocation in urban areas being put before the Canadian Transport Commission under the Railway Relocation and Crossings Act.

Schedule	June 1975 - March 1976
Funding	\$166,000
Recent Progress	Project completed.
Project Number	5045
File Number	D 500-208-3
Contractor	Canadian Pacific Consulting Services
Subcontractor	Canac Consultants Limited
Reports	<ul style="list-style-type: none"> • Urban Railway Inventory, CPCSS - March 1976 <ul style="list-style-type: none"> Volume I - Halifax, Quebec Volume II - Montreal (Inventory Forms) Volume III - Montreal (Maps) Volume IV - Ottawa-Hull, Hamilton Volume V - Kitchener-Waterloo London, Windsor Volume VI - Winnipeg, Regina Volume VII - Calgary, Edmonton Volume VIII - Vancouver.

Study of Existing Rights-of-Way for ICTS Applications in Canadian Cities

Description

To provide the desired capacity and meet automation objectives, intermediate capacity transit systems require exclusive rights-of-way, or at least priority use of rights-of-way. One possible alternative which meets this requirement and at the same time permits low cost and rapid system implementation is to use existing urban corridors, particularly urban railway alignments. This study was undertaken to identify such possible rights-of-way in 11 principal Canadian urban centres and, by examining their conformity with present and future urban travel patterns, to assess the future potential of these existing corridors for ICTS applications.

The procedure used in carrying out the study was to first identify the existing rights-of-way in the area and to collect available information on present and future employment, population and travel demand. Based on this data a forecast for 1985 transit demand in the commuter sheds served by these alignments was developed from which the rights-of-way with sufficient potential demand to justify future ICTS service were isolated. For the purposes of this study the capacity range of ICTS is assumed to be between 4000 passengers per hour in the peak direction (pph/pd) and 20,000 pph/pd. The lower limit reflects the capacity which can be handled effectively by local bus transit and the upper limit, the level at which a high capacity transit systems starts to become feasible.

Finally, those corridors identified as having sufficient potential ICTS demand were further screened as to accessibility, competitive advantage over existing transit routes and environmental acceptability.

The results are compiled in individual reports on each of the urban areas studied.

Schedule

March 1975 - March 1976

Funding

\$130,000.

Recent Progress

Project completed.

Project Number

5044, 5130

File Number

D 500-208-2

Contractor

De Leuw Cather, Canada, Ltd.

Reports

- A Study of Existing Rights-of-Way for Intermediate Capacity Transit Applications in Canadian Cities, De Leuw Cather, Canada, Ltd.-1976.

Advanced Technology Study/ICTS

Description

This study was undertaken to investigate the concept of an intermediate capacity transit system based upon small steel wheel on rail vehicles and linear induction motor (LIM) propulsion. This was done through detailed analysis of certain advanced technology areas pertaining to:

- vehicle dynamics and stability
- propulsion control system
- system power supply.

Mathematical models are used to analyze the motion of several potential vehicle configurations with respect to passenger comfort and LIM efficiency. The most promising arrangement appears to be with the LIM mounted on a stiff chassis which is supported by two axles and which in turn supports the vehicle body through a spring and damper system. Hunting instability is studied using computer programs to analyze the effect of varying significant suspension parameters. Stability against overturning, under typical operational conditions, is also considered. The effect on vehicle stability of coupling vehicles into trains is discussed. The analysis indicated that a relatively simple vehicle configuration can be designed to function within a stable range under the operational conditions considered.

The study also examines the performance of a Linear Induction Motor propulsion unit in a typical vehicle; and compares various methods of motor control and power supply systems. Within the limits of the study, the choice of control method is shown to be between the d.c. inverter and the a.c. cyclo-converter systems. Most effective utilization of currently-available equipment indicates power distribution by 750V d.c. or 4160V three-phase a.c.

The d.c. system appears least costly under present conditions, but further development of thyristor technology may bring the advantages of the a.c. system within a comparable cost range.

The results are reported in two volumes. Volume I deals with vehicle dynamics and stability and Volume II with propulsion control and power supply.

Schedule	October 1973 - April 1974
Funding	\$75,000.
Recent Progress	Project completed.
Project Number	
File Number	D 500-191
Contractor	Hawker-Siddeley Canada Ltd.
Reports	<ul style="list-style-type: none">• Advanced Technology Study. Intermediate Capacity Transit - April 1974. Volume I - Mechanical Volume II - Electrical

Evaluation of Radio Linked Signaling for Urban Transit Applications

Description

The feasibility of using radio linked signaling as a cost effective alternative to conventional automatic block signaling has been satisfactorily demonstrated for single track railway applications over long distances with relatively long headways (5 miles or longer). This project is intended to undertake a system definition and evaluation of a radio-linked signaling system for potential application to urban transit systems where line lengths are usually much shorter and headways correspondingly so when compared to conventional rail. The study will review the development status of radio linked signaling systems both in Canada (Glenayre) and elsewhere. A comparison will be made of the technical feasibility, costs and relative advantages of this technological approach as compared to alternative signaling systems currently under development.

Schedule

March 1976 - July 1977

Funding

\$49,925.

Recent Progress

Work is underway.

Project Number

6277

File Number

D 500-353-1

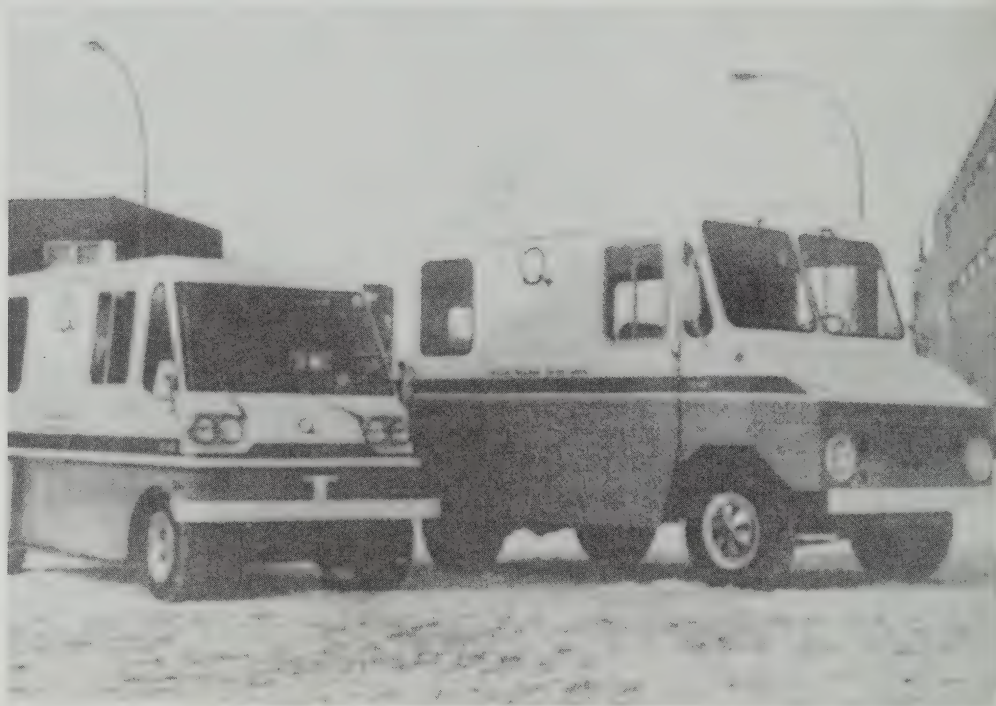
Contractor

Urban Transportation Development Corporation

Reports

None to date.

Propulsion/Improved Energy Utilization Projects



Electric Delivery Van in Montreal currently undergoing road tests by Quebec Hydro - Page 65.

A.C. Motor Multi-Axle Drive for Transit Cars

Description

The a.c. motor is smaller, lighter, more reliable and less expensive than the equivalent d.c. motor and has supplemented d.c. motors in all applications except for high power systems where precise speed control is required. For such applications where speed control is important the total d.c. drive system, including the motor controller, is simpler and less expensive than a.c. However new solid state electronic devices offer the promise of a reliable a.c. motor controller.

A research project recently completed at the University of Toronto has resulted in a successful laboratory demonstration of a single ac motor drive system for traction applications. The essential elements of the system are a squirrel cage induction motor driven by a current source inverter using power factor control circuitry and special protection devices to improve reliability.

The main objective of the current project is to perform an in-depth theoretical investigation of multi-axle/multi-motor applications in order to develop design principles which can lead to a practical a.c. propulsion system. Researchers will develop specifications for multi-axle drive applications, (e.g. practical wheel tolerances, permissible torque imbalances among motors under various operating conditions, anti-skid requirements, etc.) and define the specific design options possible. For each option a methodology will be developed to estimate cost, weight and reliability factors. These principles will be verified experimentally. A system design optimized for a typical application (e.g. subway car) on the basis of cost, weight, reliability and failure mode considerations will be developed by the research team.

Schedule

April 1976 - October 1977

Funding

\$100,000.

Recent Progress

Work on three design options has been completed. A fourth option has been identified and the contract extended to include it.

Project Number

6219

File Number

D 500-237-3

Contractor

University of Toronto

Reports

- AC Motor Propulsion System for Rail Applications, S.A. Rosenberg, S.B. Dewan, A. Joshi, G.R. Slemon, May 1976.

Survey of Electric Vehicle Test Experience

Description	This survey was intended to review and describe experience with electric road vehicles in Canada. Only vehicles which were actually manufactured have been included.
Schedule	August 1976 - April 1977
Funding	\$5,000.
Recent Progress	Project completed.
Project Number	6332
File Number	D 500-285-1
Contractor	C. R. S. Haslam
Reports	• Experience with Electric Road Vehicles in Canada, C.R.S. Haslam - 1977.

Feasibility Study of Limited Range Electric Vehicle

Description

Electric vehicles are not new. Many of the first automobiles were electrically propelled but these were superseded by the internal combustion gasoline engine. The main problem with electric vehicles of today is the same one which plagued the early electric automobiles - lack of a suitable energy storage device. This is best expressed in terms of energy storage density. The energy storage density of a lead-acid battery is about 12 watt-hours/pound compared with an energy capacity of several thousand watt-hours/pound the I/C engine system. Furthermore the car propelled by an internal combustion gasoline engine can be "recharged" in a matter of minutes whereas it takes several hours to properly recharge today's lead-acid batteries.

This project is intended to assess current work in electric vehicle and energy storage device development, examine the economic feasibility of such vehicles in the Canadian context, and to evaluate the market potential in Canada for a limited range electric automobile or utility delivery van.

Schedule

April 1977 - April 1978

Funding

\$88,540.

Recent Progress

Project implemented.

Project Number

6318

File Number

D 500-348-1

Contractor

N. D. Lea & Associates

Reports

None to date.

Flywheel Energy Storage

Description

Modern flywheel energy storage devices appear to offer good potential for improving the energy efficiency of transportation systems and possibly of service as a prime, on-board vehicular energy source. This project is intended to review the current status of flywheel energy storage so as to determine the most promising future applications for these devices. Investigators will evaluate development risks and problems against the potential benefits of this type of energy storage.

Based on the information obtained during the study a set of alternative development policies with appropriate supportive material will be outlined for future consideration and possible implementation by TDC.

Schedule

August 1976 - March 1977

Funding

\$86,025.

Recent Progress

Final report being drafted.

Project Number

6228

File Number

D 500-170-2

Contractor

Urban Transport Development Corp.

Reports

None to date.

Diesel/Flywheel Computer Simulation Study

Description

The objective of this project was to identify and develop the necessary mathematical, simulation and computing tools for an appropriate assessment of hybrid drive systems suited to various transport applications. The study was intended to:

- Establish the general characteristics of a hybrid drive system suitable for operations in paratransit and other urban transport applications.
- Define a suitable diesel/flywheel hybrid drive system based on the specifications for the diesel powered small bus of the Urban Transportation Development Corporation.
- Size the vehicle hybrid drive components to achieve the minimum possible fuel consumption over selected duty cycles.
- Compare the hybrid drive performance to that of a standard drive system.
- Identify system limitations and areas requiring further study.

Schedule

November 1975 - March 1976

Funding

\$25,000.

Recent Progress

Project completed.

Project Number

5126

File Number

D 500-257-1

Contractor

University of Toronto.

Reports

- Design and Evaluation of a Flywheel Hybrid Power Train for Minibus Vehicles.
Part I: General report, Optimal Performance by R.C. Flanagan, R. St. Laurent, L.A. Suokas - March 1976.
Part II: System Design and Modelling by R.C. Flanagan, R. St. Laurent, L.A. Suokas - March 1976.

Tracked Levitated Vehicle Technology

Numerous research and development programs addressing the application of magnetic fields to support and propel rapid transport vehicles are underway around the world. Two alternative magnetic levitation systems are being investigated:

- i) Electrodynamic (repulsion) system
- ii) Ferromagnetic (attraction) system

Non-contact suspension and guidance systems necessitate a non-contact propulsion system. Consequently both the linear synchronous motor (LSM) and the linear induction motor (LIM) are being considered and researched. TDC program effort has been focussed on the LSM concept as it has the potential, using superconducting magnets, for efficient high-speed propulsion with large vehicle-to-guideway clearances, a distinct advantage under Canadian winter conditions.

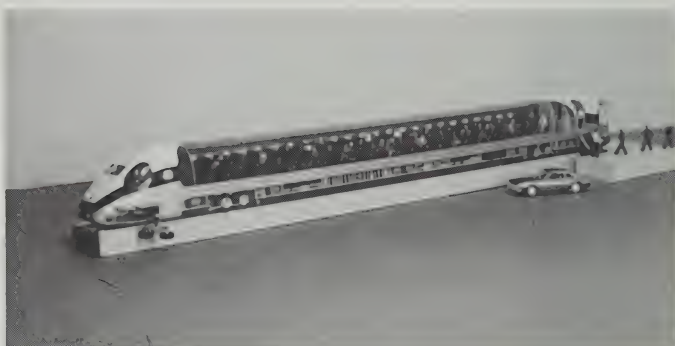
The Canadian research in the LSM field has produced very encouraging results. Emphasis for propulsion will continue to be placed on LSM development through a combined analytical/experimental approach using both large and small scale test facilities. The program is intended to create the essential knowledge and basic competence necessary to make a meaningful assessment of the potential of this advanced technology to meet the longterm needs for high-speed (300 mph) ground transport in Canada, and to address those areas most requiring research effort.

Reference - Status of Magnetic Levitation and Linear Motor Research Activities in Canada, P.L. Eggleton, TDC, Oct. 1976.



Top:
Canadian Magnetic Levitation
Vehicle (CMLV) under study
by the National Research
Council - Page 71.

Right:
Cut-away view of CMLV model
showing proposed seating arran-
gement and undercarriage.
- Page 72.



Magnetic Levitation Research Phase III

Description

Phase III of the Magnetic Levitation Program is designed to continue and to bring to a point of consolidation the Canadian research into electrodynamic, magnetic levitation and linear synchronous motor propulsion for high-speed ground transport. Phase I of the program concerned itself with analytical studies of levitation magnet design, linear synchronous motor (LSM) propulsion systems and with the conceptual design of a large scale test facility.

The major accomplishments of phase II included the detailed design, construction and commissioning of a large test wheel facility; and the construction and successful initial testing on this facility of a single-pole linear synchronous motor (LSM) utilizing a full-size superconducting magnet. Extensive theoretical studies relating to levitation, guidance, propulsion, control, communications, damping and guideway configuration also formed part of Phase II work.

Phase III involves further use of the test facility to enable researchers to verify and refine their theoretical predictions. A technically feasible maglev system suited to Canadian applications will be defined through theoretical analysis and experimental verification of the significant parameters. Mathematical models will be developed describing the performance of the system from 0 to 300 mph.

Schedule

April 1975 - September 1977 (Phase III)

Funding

Phase I - \$59,000.
Phase II - \$350,000.
Phase III - \$495,000.

Recent Progress

Research work completed, final report being drafted.

Project Number

5137

File Number

D 500-7-2

Contractor

Canadian Institute of Guided Ground Transport

Reports

- Study of Magnetic Levitation and Linear Synchronous Motor Propulsion, CIGGT, 1972.
- Analysis of Superconducting Magnetic Levitation and Linear Synchronous Motor Propulsion for High Speed Guided Ground Transportation, CIGGT, 1973.
- Superconducting Magnetic Levitation and Linear Synchronous Motor Propulsion for High Speed Guided Ground Transportation, CIGGT, 1975.

Appraisal of Maglev Concepts

Description	This study is intended to integrate the theoretical design concepts of the Canadian Maglev Group into a feasible vehicle/guideway engineering package which can be more readily understood and compared with design approaches being proposed in other countries. The study will provide an independent technical appraisal of the Canadian electrodynamic maglev concepts, to evaluate the results of the program to date, and to assess the future development potential of this technology within the Canadian context.
Schedule	March 1976 - March 1977
Funding	\$27,000.
Recent Progress	System integration and basic vehicle design complete. Comparison and appraisal underway.
Project Number	5168
File Number	D 500-7-3
Contractor	National Research Council
Reports	None to date.

Linear Induction Motor (LIM)

Research

Description

Considerable interest has been shown in the application of linear induction motors for the propulsion of transportation vehicles. Despite the fact that a number of linear induction motors have been constructed in different countries the theory of their operation is not yet completely understood. Among the problems which require particular attention are end effects and the use of compensating windings to improve motor performance.

This project has been directed toward a fundamental mathematical analysis of the linear induction motor. A quasi-two-dimensional model has been developed and a computer program (MOCOP) has been produced for evaluation of different linear induction motor designs. The MOCOP program includes provision for study of:

- LIM end effects
- the influence of a finite width motor secondary
- the effect of compensating windings

for both a constant current and a constant voltage motor control.

Calculated values of LIM performance have been compared with experimental results obtained on a 1.7 meter diameter LIM test wheel located at Ecole Polytechnique. In addition comparisons have been made between theory and practice for the Spar Aerospace Limited TLM 106 linear motor operating on the Spar linear test track facility. Good accord was obtained between theoretical predictions and test results.

Schedule

January 1975 - March 1977

Funding

\$20,000.

Recent Progress

Project completed.

Project Number

5047

File Number

D 500-211

Contractor

Centre de recherches sur les transports, Université de Montréal.

Reports

- Etude Théorique et Comparaison Expérimentale du moteur linéaire à Induction Compensée, l'Ecole Polytechnique de Montréal - février 1977.

Dynamics of Tracked Levitated Vehicle Suspensions

Description

The objectives of this project were to complete nonlinear tracked air cushion vehicle (TACV) suspension dynamic studies and to test experimentally, using the dynamics heave table, a hinged-lip and an open-loop TACV suspension model.

The dynamic response of a tracked air cushion vehicle suspension system was investigated both theoretically and experimentally. The experimental results were obtained by using a servo-hydraulically driven heave table to simulate long wavelength disturbances. A feature of the tests was the use of scaled disturbances to examine the importance of non-linearities. These results are compared with the solutions to a set of modified non-linear differential-algebraic equations previously developed for a two dimensional model. The solutions to the equations were obtained by using a high level simulation language known as Continuous Systems Modeling Program (C.S.M.P.). Good agreement between theory and experiment is obtained for both the static stiffness in heave and the dynamic frequency response behavior.

This project addressed the investigation of the characteristics of a longitudinal flux E-shaped magnet such as might be used in the electromagnetic attractive suspension of advanced transit systems. The intent was to determine the static and dynamic behaviour of the magnet experimentally and compare this with analytical results.

Static tests were carried out to determine the magnet force variation due to changes in current, air gap and lateral offset of the magnet with respect to the rail. These results were compared with two analytical models. A simple model was used in the unsaturated region of the magnet characteristic. The model assumes infinite permeability in the iron and neglects all losses and produces results which agree well with experiment for this unsaturated region.

In dynamic tests the response of the magnet to perturbations in the current and air gap was measured. Properties similar to a first order linear system for small perturbations were indicated. It was found that the sensitivities to disturbances at low frequencies could be predicted from the slopes of the static characteristics. As the perturbations are increased, the nonlinear nature of the system becomes apparent.

Schedule

July 1974 - March 1977

Funding

\$82,000.

Recent Progress

Project completed. Final report due.

Project Number

5046

File Number

D 500-210

Contractor

University of Toronto
- Department of Electrical Engineering (Ferromagnetic)
- Institute of Aerospace Studies (Flexible-skirt TACV).

Reports

- Tracked Air Cushion Vehicle Suspension Dynamics, P.A. Sullivan, UTIAS - February 1974.
- E-Shaped Electromagnetic Suspension Magnet-Calculated and Experimental Static and Heave Force Characteristics, University of Toronto - March 1976.
- A Theoretical and Experimental Investigation of a Hinged Lip Tracked Air Cushion Vehicle Suspension System, P.A. Sullivan, J.G. Parravano UTIAS - March 1977.

Off-Road Transport Research

Off-road vehicles are those vehicles able to operate in conditions unacceptable to standard cars and trucks. They are used in civil engineering, in forestry, and for general transport tasks associated with exploration and remote construction work.

Generally all vehicles have some off-road capabilities: it is the degree in which these capabilities exist, be it floatation, tolerance to surface irregularities or propulsive proficiency, that distinguishes the off-road class from the highway vehicles. Because of the highly variable nature of the environment it is impossible to describe a standard off-road vehicle: it is the mission that defines the vehicle morphology.

The TDC development program concerns itself with off-road transport in conditions typical of the Canadian terrain characterised by the prevalence of organic soils and of sandy silts highly susceptible to water content. These terrains are fragile: multiple passages by vehicles will destroy their surface; in early spring even well prepared dirt roads become impassable.

The general objective of the development program is to improve off-road transport means so as to reduce the scale of investment required for access to the Canadian hinterland.



*Top:
Cushion Air System Parametric
Assessment Rig HEX-1A on
multicell skirt in a swampy
forest track during trials
carried out by the National
Research Council - Page 82.*

*Left:
Air Cushion Vehicles are
suitable for use over terrain
easily damaged by conven-
tional vehicles. - Page 79.*

*Right:
Conventional Machinery bogs
down under conditions which
are readily accepted by Air
Cushion Vehicles. - Page 79.*

Towed Air Cushion Rafts

Description

Air cushion vehicle development over the past fifteen years has concentrated on vehicles for marine application and on tracked levitated guideway systems. However, in recent years, there has been a growing interest in air cushion vehicles designed specifically for overland transportation. The Towed Air Cushion Raft (TACR) is such a vehicle. It has been designed to travel over both land and water, and to negotiate obstacles up to two feet in height. Locomotion is provided by a towing vehicle with characteristics best suited to the prevailing terrain condition. This may be tracked or wheeled ground vehicle, a capstan winch, or possibly even a helicopter. Such a transport system is considered to have good potential for resource exploitation in remote areas.

During the summer of 1973, the Transportation Development Centre, in conjunction with Hydro-Quebec undertook the field evaluation of two TACR's of dissimilar design but each with a 15-ton capacity. The test area was a transmission line construction site in the Ragueneau region near Baie Comeau, Quebec. The tests met with limited success and it was recommended that the prototype rafts be transformed into a fully reliable transportation system.

Tests also determined the lateral and longitudinal trim and stability, using both the Bertin skirt system and a modified skirt which may be considered as a prototype of a multicell design. The objective of the project was to measure the baseline performance of an Hover-Jak HL-15 raft and thus establish a basis for further development.

A market study carried out in conjunction with the technical work has indicated a demand of 40 air cushion raft units of 20 to 40-ton capacity over the next five years, which would have an estimated value to industry of 15 to 25 million dollars. TDC maintains an interest in this technology although no follow-on projects have yet been identified.

Schedule	February 1975 - June 1975
Funding	\$105,000. (a) \$57,000. (b) \$5,000. (c)
Recent Progress	Project completed.
Project Number	5055/5056
File Number	D 500-221-1
Contractors	Hydro-Quebec (a) Hover-Jak Ltd. (b) J.W. Harrison and Associates (c)
Reports	<ul style="list-style-type: none"> • Investigation of Towing Systems for Air Cushion Rafts, May 1975 Hover-Jak Ltd. • Summary Report on Baseline Trials - June 1975 Hover-Jak Ltd. • Market Potential, Towed Air Cushion Rafts in Canada, September 1975 J.W. Harrison • Field Evaluation of Air Cushion Rafts - January 1974 TDC, P.L. Eggleton & J.E. Laframboise • Evaluation des Aérobags - CDT - P.L. Eggleton 1974.

Flexicell Air Cushion System

Description

This project was for the comparative evaluation of the flexicell air cushion system conceived by Jones, Kirwan and Associates, Hagersville Ontario with other air cushion designs. The basic static and dynamic characteristics of the Flexicell system were measured and compared to those of multicell and loop and segment systems.

The flexicell design is a Canadian evolution of the basic multicell air cushion system. Its application is primarily for overland air cushion vehicles on Canadian off-road and northern transportation routes. The flexicell design has the potential of overcoming most of the performance short-comings of licensed foreign air cushion systems operating in the Canadian environment.

Snagging is expected to be less than that encountered with conventional conical cell vehicles. An important feature of the flexicell system is the ability to withdraw separate damaged cells in the field. Compared to the multicell and peripheral skirt system, the flexicell should provide equivalent cushion area and increased stabilisation with equal pressure reserve without incurring the complexity of a peripheral skirt. Once cells are sealed to the ground the stabilising moment increases over that of the multicell system as a shift of the reaction area take place similar to that of the loop and segment system.

The data gathered from these investigations will be such that the behaviour of an overland air cushion vehicle fitted with the flexicell system can be predicted.

Schedule

April 1974 - October 1975

Funding

\$76,500.

Recent Progress

Project completed.

Project Number

5041

File Number

D 500-203-1

Contractor

University of Toronto - Institute for Aerospace Studies
(U.T.I.A.S.)

Reports

- "Hysteris and Fabric Effect" Report of Flexicell project as UTIAS/ TDA - May 1976
- Investigation of the Roll stiffness characteristics of three flexicell skirted cushion systems. P.A. Sullivan, M.J. Hinchey, R.G. Delaney UTIAS 1976

Cushion Air System Parametric Assessment Rig (CASPAR)

Description

Since 1972 the National Research Council has operated a cushion air system parametric assessment rig. This is a basic air cushion rig which is designed to be easily fitted to different ACV skirt systems. It is used to test skirt characteristics and skirt/terrain interaction. The rig consists essentially of a girder frame on which are mounted a lift system, an auxiliary thrust system, a ballast system, and a cabin for the crew. All elements of the rig are heavily instrumented. The rig is mounted on a windbox which is peculiar to the skirt being tested. The windbox mounts the skirt attachment points and contains the duct system to distribute lift air from the blowers to the skirt elements. Both skirt and windbox are designed by the skirt manufacturer and together comprise the system to be tested.

The test rig, windbox and skirt, when assembled, form an air cushion research vehicle which can be used in an R & D program to generate field data under closely controlled conditions. Research in the CASPAR program addresses skirt materials, terrain/vehicle interaction and skirt design.

The objective of the program is to produce data sheets that would enable a vehicle-designer to select the appropriate skirt system to meet a particular requirement.

Schedule

August 1972 - March 1978.

Funding

TDC - \$10,000/year
NRC - \$80,000/year
Quebec - \$2,500/year

Recent Progress

Tests continuing.

Project Number

5182

File Number

D 500-155-1

Contractor

National Research Council.

Reports

- The CASPAR ACV Research Project
 - Report No. 1: Programme and Basic Data -March 1974 (NRC).
 - Report No. 2: The Sensitivity of a Two Fan Single Engine, Multicell ACV to Individual Fan Performance -September 1974 (NRC).
 - Report No. 3: The Drag of Air Cushion Vehicles Overland - February 1975 (NRC).



Top:
Tractor-trailer used by the
Ministry of Transportation
and Communications of
Ontario in the testing of an
anti jack-knife device
- Page 86.



Left:
Air Cushion Vehicle with
experimental test cell mounted
at rear of truck used to study
the air cushion pressure effect
on pavement - Page 88.

Right:
Materials being expelled under
air cushion pressure of 5 psi
during tests conducted on
secondary roads in the
Province of Ontario - Page 88.

Highway Ice Removal Using High Intensity Light

Description	<p>The overall objective of the highway ice removal project is to develop a vehicle that will remove ice or compacted snow remaining on the pavement surface after conventional cleaning. The target performance is removal of ice or snow one-half inch or less in thickness over a road width of 12 feet, at a speed of 15 miles per hour.</p> <p>Previous research has developed the principle of breaking the bond between ice-snow and pavement surface by intense radiation heating of the ice-snow/pavement interface through the use of plasma-arc lamps mounted on a road vehicle.</p> <p>The current project is intended to enable an operational demonstration of the feasibility of the principle and thus generate design data necessary for a full-scale operational vehicle.</p>
Schedule	December 1976 - March 1978
Funding	\$89,000.
Recent Progress	Specification for plasma-arc lamps defined.
Project Number	6230
File Number	D 500-322-1
Contractor	British Columbia Research
Reports	None to date.

Tractor-Trailer Anti-Jack-Knife Device Testing

Description	<p>A large number of tractor/trailer vehicles are in use in the Canadian transportation system. This project has been designated specifically for the purpose of developing a better understanding of the design and operating factors which affect the handling, stability, controlability and braking performance of these vehicles.</p> <p>The research consists of full scale vehicle testing, followed by analysis and simulation of the operation and effect of jack-knife control devices and the dynamic conditions leading to jack-knifing and trailer swing. The devices are being tested in a tractor-trailer combination under operating conditions normally resulting in vehicle instability - lane change maneuvers and braking under various load configurations. These same devices will be modelled and included in a tractor trailer digital computer simulation for comparison and evaluation of configurations not tested full scale.</p>
Schedule	August 1976 - December 1977
Fundings	TDC - \$106,409. MTC (Ontario) - \$90,380.
Recent Progress	Full Scale testing underway.
Project Number	5294
File Number	D 500-246-2
Contractor	Ministry of Transportation & Communications (Ontario).
Reports	None to date.

Vehicle Weight Monitoring

Description	<p>The introduction and wider usage of larger, heavier and more powerful vehicles on Canada's highways has created demands upon the system that cause more rapid deterioration of existing pavements and structures, increases the costs of new pavements and structures because of the more stringent requirements, and increases maintenance costs of existing roadways. In order to effectively assess the social and economic impact of upward shifts in axle weights and vehicle dimensions reasonably, accurate information must be available on the frequency and magnitude of the various loads which are imposed on pavement and bridge structures. Present methods of static weight sampling do not produce the detailed information necessary for an impact assessment. This project addresses the problem of evaluating various weigh-in-motion scales which would measure actual load weights of all vehicular traffic over a particular point.</p> <p>The evaluation will include field experiments to test promising weigh-in-motion scales in the Canadian environment.</p>	
Schedule	October 1976 - August 1978	
Funding	TDC	\$203,600.
	University of Saskatchewan	\$ 40,000.
	Saskatchewan Dept. of Highways	\$ 25,000.
	Province of Alberta	\$ 23,000.
	Province of Ontario	\$ 65,000.
	Province of Quebec	\$ 25,000.
	Province of New Brunswick	\$ 35,000.
	Total:	<u>\$416,600.</u>
Recent Progress	Work in underway.	
Project Number	6269	
File Number	D 500-294-1	
Contractor	Roads & Transportation Association of Canada	
Reports	None to date.	

Air Cushion Pressure Effect on Pavement

Description

Roads that have the strength to provide unrestricted use throughout the year are expensive to construct and maintain and are usually not warranted for the northern and rural areas of Canada. Consequently load restrictions are in force in these areas much of the time.

The problem can be overcome by the use of an air cushion assist unit placed under the vehicle to reduce the load on the tires to a point which will not jeopardize pavement or bridge structures. This project was established to determine the maximum pressures that may be used in air-cushion assist equipment when operating over roads with various surfaces and in various states of wear so as to avoid excessive erosion. Investigators also addressed the identification of vehicle related problems due to the use of the high pressure air-cushion assist.

Schedule

January 1975 - March 1976

Funding

\$90,091.

Recent Progress

Project completed.

Project Number

5057

File Number

D 500-222-1

Contractor

Hover-Jak Ltd.

Reports

- Summary Report on Road Surface Tests Using High Pressure Cushion Trailer Assist, Hover-Jak - July 1975.
- Pressure Calibrations and Noise Measurements for Hover-Jak Ltd., University of Toronto, P.A. Sullivan-August 1975.
- Permissible Air Pressure Air Cushion Assisted Vehicles G.J. Chong, Ministry of Transport Ontario.

Fuel Tax Pro-Rationing

Description	A sub-committee of the Roads and Transportation Association of Canada (RTAC) is studying several aspects of the problem of vehicle fuel-tax prorating. The intent is to gather and analyse data related to the imposition and collection of fuel taxes by various provincial jurisdictions, and their effects on the motor carrier industry. This project assists the Canadian Trucking Association in their portion of this study whereby a survey of extra-provincial carriers is made to obtain the data necessary for a quantitative analysis of the fuel-tax problem. The TDC assistance is primarily directed towards data handling and tabulation of the surveys findings.
Schedule	January 1975 - March 1977
Funding	\$4,300.
Recent Progress	Project completed. Final report being drafted.
Project Number	5086
File Number	D 500-233-1
Contractor	Roads and Transportation Association of Canada.
Reports	None to date.

Urban Trucking Rationalization

Description

This project has been conceived in response to concerns voiced by municipalities and the trucking industry over the problems caused by truck and freight movement operations in cities. Cities see the damage inflicted by large volume truck traffic in urban areas while industry complains of constraints which are costly to their operations.

It is intended to identify and develop an innovative methodology with which to define the intra-urban truck universe and major inter-city interfaces applicable to any large or medium sized Canadian city. An evaluation will be made of the impact on the urban environment of various alternate strategies in freight movement. (i.e. terminal locations, dedicated routes, etc.).

In order to permit the evaluation to be readily updated modelling techniques will be applied to the initial evaluation.

Schedule

May 1975 - March 1977

Funding

TDC - \$65,000.
MSUA - \$65,000.
City of Vancouver - \$5,000.

Recent Progress

Study of common freight terminal concept in Saskatchewan underway.

Project Number

5069

File Number

D 500-241-1

Contractor

Swan Wooster Engineering Limited

Reports

None to date.

Motor Vehicle Licensing Reciprocity Study

Description	<p>The provinces have the power of regulating extraprovincial motor carrier operations within their boundries. They exercise this power through a system of operating franchises and their motor vehicle licensing procedure.</p> <p>The lack of uniformity in commercial highway motor carrier vehicle licensing of trucks, tractors, and trailers throughout the country may give rise to inequitable situations and create some difficulties for extraprovincial carriers.</p> <p>This project will investigate, and make recommendations in the field of motor carrier vehicle licensing reciprocity.</p> <p>It will specifically evaluate various reciprocity alternatives, including the existing situation, and the impact of these alternatives on the trucking industry, governments, and the economy as a whole.</p>
Schedule	June 1976 - September 1977
Funding	\$132,160.
Recent Progress	Work is underway.
Project Number	6251
File Number	D 500-267-1
Contractor	RK House & Assoc. Ltd.
Reports	None to date.

Transport for the Disadvantaged

A "disadvantaged" individual is one who encounters mobility problems attributable to a particular physical or mental condition when he/she attempts to use a transportation service or system. It has been estimated that one in seven Canadians experiences such mobility problems. The range of physically disadvantaged persons may encompass the very young, the elderly, the blind and the deaf, the sick, patients under treatment, those with temporary or permanent disabilities, the mentally ill, and the mentally retarded.

Transportation is the key to independence for the disadvantaged. Without it, they are socially and economically isolated. With it, they have the opportunity to become employed (to become a taxpayer rather than a tax consumer) and to become involved in social and recreational affairs. Furthermore, they are provided with the chance to experience adventurous travel.



*TDC/Ball Berezowski Associates
curb-climbing wheelchair
developed for the handicapped
- Page 96.*





Small stationwagon modified to demonstrate a satisfactory method of transportation for the handicapped - Page 98.



Curb-Climbing Wheelchair for Physically Handicapped

Description	In an attempt to provide the handicapped with a greater degree of mobility this project addresses the development of a curb-climbing electrically-driven wheelchair. The design and construction of a prototype battery operated wheelchair which can climb on to and off curbs up to 10" in height has been completed. A test and evaluation of this prototype is now underway to verify the integrity of the design and to develop the necessary production configuration for its manufacture.
Schedule	February 1977 - August 1977
Funding	\$39,976.
Project Number	5165
File Number	D 500-79-2
Recent Progress	Prototype model assembled
Contractor	Ball Berezowsky Associates
Reports	None to date.

Test and Evaluation of Wheelchair Lift

Description	The project objective was to test and evaluate a prototype wheelchair lift "Lifft-Eze" under daily service conditions experienced by an operator of commercial vans transporting handicapped persons. The project obtained technical and operational data regarding the viability of a van type wheelchair lift design incorporating innovations aimed at improved safety, reliability and cost effectiveness of transporting handicapped persons in vehicles.
Schedule	May 1976 - December 1976
Funding	\$8,100.
Recent Progress	Project completed
Project Number	5198
File Number	D 500-283-1
Contractor	Wheelchair Mobile Services Ltd. Toronto
Reports	<ul style="list-style-type: none">• Study of Wheelchair Lifts and Lifft-Eze Prototype Lift. French and Carpenter WMS,Ltd.

Testing of Small Vehicle for Transportation of the Handicapped

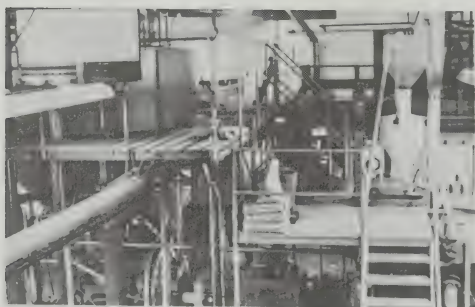
Description	A study by the Alberta Rehabilitation Center in 1975 revealed that the transportation needs of the handicapped would be best met by a small vehicle which would accommodate 2 persons in wheelchairs and one walking handicapped person. In the current TDC project investigators will modify and test a small station-wagon to establish if such a vehicle is satisfactory from the standpoint of safety, comfort and economy for the transportation of the handicapped.
Schedule	January 1977 - June 1978
Funding	\$23,500.
Recent Progress	Vehicle modifications are completed and service trials have commenced.
Project Number	6281
File Number	D 500-358-1
Contractor	Minibus Forest Inc.
Reports	<ul style="list-style-type: none">• "Handi Buses and the Adult Client", Alberta Rehabilitation Center.

Solids Pipeline Research

Pipelines have long been used for transporting fluids. In the last decade, the pipeline transport of minerals in either slurry or capsule form has reached the stage of practical feasibility. The demand for minerals from Canadian deposits is expected to continue to rise. The location of the mineral deposits exploited will be in increasingly remote areas as nearby existing deposits become exhausted. As a result, the transport of mineral commodities in bulk will become a more challenging task. Traditionally, minerals have been transported to ports or consumption sites by unit trains. Solids pipelining is considered the next step to unit trains; its potential for the movement of bulk commodities lies in its relatively fixed operating costs over time, lower construction and maintenance costs, negligible pollution, and the fact that mines are permitted to locate in remote rugged areas where railway construction costs would be prohibitive. Solids pipelining can exist in slurry form (fine particles suspended in a carrier fluid) or in capsule form (cylinders or spheres transported in a carrier fluid).

The land-locked prairie provinces have a specific interest in solids pipelining as an alternative to total dependence on the rail mode for transport of their bulk commodities. The long range transport of Alberta coal to central Canada is a subject of various engineering studies.

TDC support for research and establishment of flow characteristics for a range of candidate mineral commodities has been undertaken for slurry and capsule forms at the Saskatchewan Research Council (SRC) and Research Council of Alberta (RCA) respectively. An objective of the TDC support to both solids pipeline centres was to build up an investigating team and facilities such that the research organizations could continue on a self-sustaining basis through contract research and consulting with industry as, and when, market conditions demand their services. Both establishments have established world-wide reputations based on their contributions in their respective solids pipeline fields over the last ten years. SRC continues to develop data for various slurry pipeline feasibility studies; RCA is investigating opportunities for capsule pipelining where its lower energy requirements and unique applications, such as urban solid waste removal and short range transport of commodities requiring encapsulation, are significant.



*Top:
Overview of large scale and
4 inch mixing tanks and pump
assemblies of the Slurry pipe-
line research facilities in
Saskatoon. - Page 102.*

*Left:
Exterior view showing 6 inch
& 10 inch loops with 6 inch
sloped line in centre field of
the Slurry pipeline research
facility of the Saskatchewan
Research Council in Saskatoon.
- Page 102.*

*Right:
Capsule pipeline control
valving for 10-inch diameter
test line (test capsule in
background). - Page 101.*

Capsule Pipeline Research

Description	<p>The objective of this project was to further the understanding of the movement of commodities in capsule form through pipelines thereby enabling more reliable judgements of the economics of the process to be made, and encouraging a realistic assessment of the suitability of this form of transportation to Canadian applications.</p> <p>The investigators addressed the problem of the hydrodynamics of capsule movement through experimental and analytical work on instrumented research pipelines ranging in size from 1/2 inch to 10 inches.</p>
Schedule	January 1971 - March 1975
Funding	TDC - \$535,000. Research Council of Alberta - \$315,000.
Recent Progress	Project completed.
Project Number	
File Number	D 500-41-3
Contractor	Research Council of Alberta
Reports	<ul style="list-style-type: none">• Capsule Pipelining, Potential Applications 1973, E.J. Jensen, Alberta Research Council. (3 Vol.)• Capsule Pipeline System Analysis, Alberta Research Council - 1975.• Capsule Pipeline Project<ul style="list-style-type: none">Phase 1 Report, E.J. Jensen - 1973.Phase 2 Report, E.J. Jensen - 1974.Phase 3 Report, E.J. Jensen - 1975.• Fortran Program to Determine System Parameters and Operating Costs for a Capsule Pipeline to Transport Solid Waste from Urban Centres to Remote Landfill Sites - P. Mainella - TDC - 1972.

Slurry Pipeline Research

Description

More than 90 percent of Canada's coal reserves are located in Western Canada, primarily Alberta and British Columbia. The principal markets for this coal are the thermal generating plants of Ontario Hydro and exports through Pacific Coast ports. Slurry pipelining is the alternative to the rail mode to move the huge volumes over the long distances involved. The slurry pipeline program underway since 1971 at the Saskatchewan Research Council (SRC) in Saskatoon, has established the technical feasibility of transporting a range of solids in slurry form in long distance pipelines.

A problem now being addressed is how best to access coal deposits in remote mountainous regions and where best to locate the crushing and preparation plants. It has been proposed that many mine sites could become viable if a short range coarse coal slurry line (as a more economical alternative to building a railway spur line) could connect the mine with a preparation plant located more conveniently at a railhead or seaport.

The primary objective of the current Saskatchewan Research Council (SRC) investigation is to determine the performance of selected "coarse" coals (crushed to 1 1/2-inch diameter or less) under a variety of conditions.

Each of the coals selected will undergo preliminary testing in the 4" pipeline test loop at SRC prior to final testing in the 6" to 12" pipeline test loop system. At each stage of testing, energy requirements and attrition rates will be measured for up to eight flow rates, five concentrations and at least two particle size range conditions. Then the results will be used to determine the optimum conditions for which a mine-mouth-to-preparation-plant pipeline should be designed, and several test runs will be made on each size of pipeline under these optimum conditions. Finally, using the results of the test runs at optimum conditions, a typical mine-mouth-to-preparation plant pipeline would be designed for demonstration purposes.

Schedule	September 1976 - November 1978
Funding	\$61,000.
Recent Progress	Testing of 3/4 inch lignite coal underway with 25 percent, 30 percent and 35 percent runs complete.
Project Number	6262
File Number	D 500-6-5
Contractor	Saskatchewan Research Council
Reports	<p>From previous project.</p> <ul style="list-style-type: none"> • Experimental studies of solids pipelining of Canadian Commodities (9 Vol.), W. Schriek, L.G. Smith, D.Haas, W.H.W. Husband of Saskatchewan Research Council, Engineering Division - July 1973. • Experimental Studies of the Pipelining of Coal-in-Oil Slurries, L.G. Smith, W.H. W. Husband, D. Haas, A. Richardson of Saskatchewan Research Council, Engineering Division - March 1976.

Air Technology



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Demonstration Projects



TOP

The DHC-6 ready for take-off at the STOLport in Montreal during the Ottawa-Montreal demonstration service.
- Page 109.

LEFT

DHC-6 approaching Montreal's STOLport. - Page 109

RIGHT

STOLmobile used to transport passengers from terminal building to specific downtown locations - Page 109.

STOL Demonstration

Description

The Short Take-off and Landing (STOL) Demonstration was a major program undertaken by Transport Canada to define and develop a new intercity air transportation system. The demonstration was to test not only the operational feasibility of regular STOL service but also passenger acceptance, community reactions and the impact of the service on an urban environment. It was intended that this high profile program would stimulate domestic and international markets for the STOL system concept.

STOL ports were built in Montreal and Ottawa, six de Havilland Twin Otter aircraft were purchased in a configuration suitable to a first class passenger demonstration and specially modified for STOL operations in urban areas, and an airline was set up to operate the service.

Air Canada contracted to set up a subsidiary airline, Airtransit, for the demonstration; Transport Canada provided airport facilities and services. The responsibility for contracting the design and development of the necessary modifications to the Twin Otter was assigned to the Canadian Air Transportation Administration (CATA).

Within the framework of the demonstration TDC was responsible for collecting information from the demonstration activities that would enable objectives of a test nature to be evaluated specifically to test operational feasibility, to test passenger acceptance, to test community acceptance, to test economic viability and to stimulate national and international markets and define market strategies. A special group was established to design the data gathering system and to collect, store and analyse the vast amount of data from various sources covering all aspects of the demonstration.

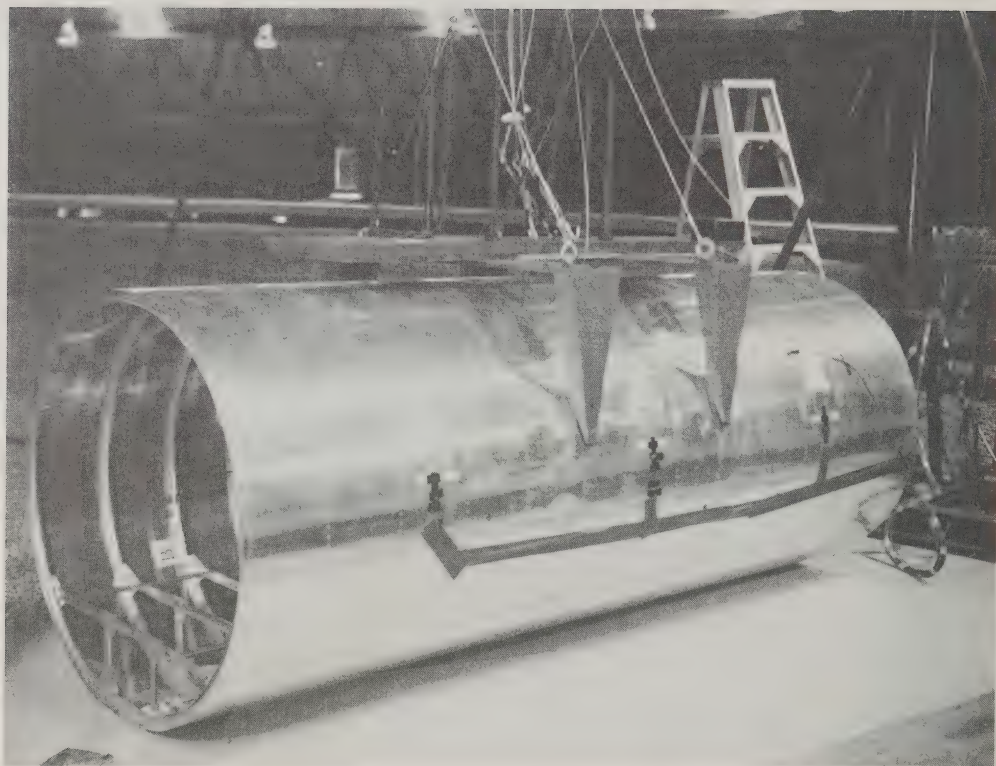
Revenue passenger service commenced in July 1974 and continued until April 1976; some 154,000 passengers were carried on 24,000 flights. During this time TDC conducted the several surveys necessary to amass the myriad of data required for the program evaluation; Traveller Awareness, Public Acceptance, Road Traveller survey, Air Transit Traveller Profile, Sensitivity Surveys, Operational Surveys etc.

Schedule	May 1974 - March 1977
Funding	Federal Government \$24.1 million
Recent Progress	Project completed.
Project Number	5009 to 5012 incl. 6243/6292
File Number	D 500-18
Contractor	TDC
Reports	<ul style="list-style-type: none"> • Airtransit Canada Report to Board of Directors - July 1976. • STOL Demonstration Montreal-Ottawa - 1974-1976 Report. TDC.

Research Supporting Air Regulations

Transport Canada has the responsibility for the regulation of aircraft standards and operational procedures within Canadian air space. The air regulations are reviewed regularly to ensure that they can accommodate new technological developments, are compatible with public concerns and do not unduly compromise aviation activities or safety. This requires the availability of data and of expertise having a basic understanding of the technical, environmental, social, economic and political aspects pertaining to relevant regulations (or lack of).

TDC is supporting research and data collection necessary to establish criteria as well as the requirements and means for operators to comply with air regulations. Work is currently underway addressing the crashworthiness of light aircraft structures, minimum safe altitude warning devices and the sonic boom phenomenon. The work is undertaken by researchers in universities, government and industry.



Fuselage with strain gauges attached used to study the stress behavior of a light aircraft structure on ground impact.
- Page 115.

Development of Minimum Safe Altitude Warning Module

Description

The crash of an airliner in Florida prompted the need for an effective means of alerting the Air Traffic Controller and in turn the pilot, if an aircraft descends below the minimum safe altitude. This project is directed toward the eventual development of a major functional module for application in Canadian ATC systems.

Investigators will determine the functional requirement from both the pilot and controller viewpoints. Techniques for extraction of aircraft height from data already available to the system will be thoroughly explored with emphasis on a module which would readily interface with current radar control systems. Software and detailed design specifications will be developed for an MSA module.

Schedule

October 1975 - March 1977

Funding

\$59,650.

Recent Progress

Final testing and evaluation of MSAW algorithms is underway.

Project Number

5170

File Number

D 500-288-1

Contractor

Digital Methods Ltd. (DML)

Reports

- Functional Specification for a Minimum Safe Altitude Warning Module, D. Fairthorne - 1976.

Sonic Boom Research

Description	<p>Aircraft operation greater than the speed of sound (600 MPH) produces a sharp shock wave or 'sonic boom' that startles humans and animals and vibrates structures. The viability of potential domestic and international commercial supersonic services is influenced by whether supersonic corridors over Canadian Territory may be permitted. Air regulations must be written accordingly, based on a sound knowledge of the Canadian context.</p> <p>This project investigates various aerodynamic, gasdynamic, psychological and physiological effects of sonic booms on humans, animals and structures. The University of Toronto Institute for Aerospace Studies (UTIAS) undertook this research in its sonic boom laboratory. The facilities used for the investigations included a loudspeaker booth simulator which mimics various N-waves, pure tones etc. and was well suited for psycho-acoustic response studies and physiological effects on small animals; and a travelling-wave horn simulator, which is able to generate superbooms and was used to study the effects of sonic booms on humans, animals and structures.</p>
Schedule	June 1974 - March 1977
Funding	\$100,000.
Recent Progress	Project completed. Final report being drafted.
Project Number	5008
File Number	D 500-15-1
Contractor	University of Toronto
Reports	<ul style="list-style-type: none">• The Effect of Wind and Temperature Gradients on Sonic Boom Corridors, R.O. Onyeonwu, UTIAS - 1971.• Lifetime Concept of Plaster Panels Subjected to Sonic Boom, B.R. Leigh, UTIAS - 1974.• Sonic Boom Analogues for Investigating Indoor Waves and Structural Response, Sui Lin, UTIAS - 1970.• Supersonic Turns Without Super booms, H.S. Ribner - UTIAS - 1971.• Canadian Sonic Boom Simulation Facilities, I. Glass, H.S. Ribner, J. Gottlieb - UTIAS 1973.• Acute Changes in Inner Ears of Laboratory Animal Caused by Simulated Sonic Booms, S. Reinis - UTIAS - 1976.

Crashworthiness of Light Aircraft Structure

Description	<p>In anticipation of legislation requiring that aircraft be designed to survive (within limits) ground impact a preliminary research program was initiated to study the dynamic stress behavior of aircraft structure. This program included drop tests of semi large-scale models of fuselage sections at the Institute of Aerospace Studies in Toronto and verification of the analytical methods employed.</p> <p>Research in the current project is intended as a follow-on to the original work. Crash simulations of both the vertical and the horizontal impact velocities as well as airframe orientation at the moment of impact will be carried out using semi-large (1/3) scale test models nominally up to 30 inches in diameter and 60 to 90 inches in length.</p>
Schedule	December 1976 - July 1977
Funding	\$30,000.
Recent Progress	Acceleration values have been predicted for various wing loadings. Mounting of model for oblique impact tests is underway.
Project Number	6293
File Number	D 500-271-1
Contractor	University of Toronto
Reports	<ul style="list-style-type: none">• Study of the Crashworthiness of Light Aircraft Structures, UTIAS, R.C. Tennyson.

Improved Energy Efficiency

Early in 1977 Transport Canada took the initiative in encouraging Canadian operators of large jet aircraft to adopt energy conservation measures by means of refined operating techniques plus appropriate regulatory changes. It was also recognized that technological changes could be introduced in future aircraft that would significantly improve their fuel efficiency. These changes lie in the areas of aerodynamics, structures and propulsion systems.

A major research and development effort is currently underway in the USA for application to transport fleets of wide body aircraft in the late 1980's. No similar effort is underway for other civil aircraft (i.e. small transports, executive jets, STOL, private pleasure aircraft etc.). The projects in this section describe basic research and development instigated in Canada by TDC which could lead to the design and development of more energy efficient aircraft and engines of a size and type suitable for Canadian manufacture, marketing and application. The projects build upon the indigenous Canadian experience developed by Pratt & Whitney Aircraft of Canada, De Havilland of Canada and Canadair to design and manufacture small gas turbine engines and smaller transport aircraft.

Fuel Efficiency Improvements for Small Gas Turbine Engines

Description

Propulsion systems for light aircraft of the future are expected to include turbo props and related propellers up to 2,000SHP and turbofans up to 3,000 lbs. thrust. In keeping with the world-wide effort to improve fuel efficiency the aim of this project was to identify basic areas where research and development could lead to an improved propulsive efficiency for this class of engine.

Investigators addressed this problem by establishing a 1976 performance baseline and defining the energy efficiency of a hypothetical family of gas turbine propulsion systems based on current technology and then revising the definition to show potential improvements in energy efficiency based on identifiable future technology.

Using this approach the fuel efficiency study has suggested research and development to engine related items under two headings:

Mechanical Aspects:

- Low Cycle Fatigue testing of "P&WC size" discs to update material LCF properties for small engines.
- Creep Life - correlation of fleet blade creep lives with calculated life, (paper study).
- Bearing Design - design and test of increased speed rolling element bearings ("high DN bearings").
- Supercritical shafts - design and test of shaft and bearing system to operate at speeds beyond that for the shaft first bending mode.

Aerodynamic Aspects:

- Single Stage Fan - design and development of advanced high pressure ratio and high efficiency fans.
- Turbine Research - research into gas generator turbines, both cooled and uncooled and characterized by high aerodynamic loading and pressure ratio. Overall effect of reduced number of blades. Effect of reduced trailing edge thickness.

- Low pressure turbine design and test to improve the technology of turbines characterized by high through-flow velocity and high loading.

Schedule	November 1976 - July 1977
Funding	\$47,352.
Recent Progress	Complete; report in preparation.
Project Number	6283
File Number	D 500-331-4
Contractor	Pratt & Whitney Aircraft of Canada
Reports	None to date.

Fuel Efficiency Improvements for Small Transport Aircraft

Description

Future manufacture of CTOL aircraft in Canada is realistically expected to be limited to 100 passenger size. Within this constraint, and with specific application to aircraft capable of high subsonic speed and short range, this project addresses the identification of design features which could impact productivity and energy efficiency in this class of aircraft.

Investigators established a 1976 performance baseline citing the productivity and energy efficiency of existing equipment. The performance of future aircraft was then defined and compared based on both current technology and identifiable future technology.

The study indicated that the major technical contributions to reduced fuel consumption for the next generation of smaller aircraft would come from:

- improved propulsive efficiency attainable with new high by-pass ratio turbofans, or advanced prop-fans.
- better lift-drag ratio achieved by higher wing aspect ratios that become feasible structurally with the thicker supercritical airfoils.

Results will be described in sufficient detail to permit costing of the analytical and experimental work necessary to verify the forecast figures.

Schedule

November 1976 - June 1977

Funding

\$54,333.

Recent Progress

Complete; report in preparation.

Project Number

6258

File Number

D 500-331-2

Contractor

Canadair Limited

Reports

None to date.

Fuel Efficiency Improvements for STOL Aircraft

Description

Future development of Canadian aircraft is expected to be limited by capital and manpower requirements to size ranges of up to 100 passengers. Within this constraint, and with specific application to short range and STOL type aircraft, this project addresses design features which would effect energy efficiency.

Investigators, using 1976 performance as a baseline, forecast and compared productivity and energy consumption based on current technology and on identifiable future technology.

De Havilland of Canada's DHC-7 performance was used as a baseline for present day STOL aircraft. Computer decks were then assembled to describe 30, 50 and 80 passenger aircraft based on the DHC-7 technology. Using identifiable future technology investigators described a 50 passenger prop-fan powered aircraft designed for Mach 0.7 cruise and a 50 passenger turbo fan powered aircraft designed for cruise at Mach numbers of 0.7, 0.75 and 0.8.

The final report will reflect parametric studies using advanced technology for the above 50 passenger aircraft and also a turbo fan powered 30 and 80 passenger aircraft designed for Mach 0.7 cruise.

Results will be described in sufficient detail to permit cost estimating of analytical and experimental work necessary to verify the forecast figures.

Schedule

November 1976 - June 1977

Funding

\$51,400.

Recent Progress

Complete; report in preparation.

Project Number

6282

File Number

D 500-331-3

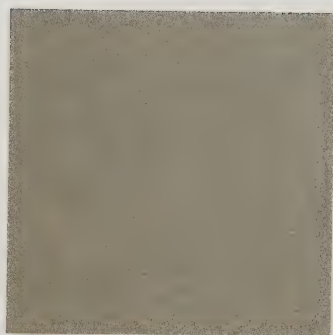
Contractor

De Havilland Aircraft of Canada Ltd.

Reports

None to date.

Marine Technology



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Icebreaking and Ice Related Research

Research programs affecting the marine mode in Canada respond mainly to increased demands for Arctic operations. Ships destined for Arctic supply and mineral exploitation will need to incorporate engineering and design features that permit ice-breaking capability. These features apply not only to the hull but also to the propulsion package, control systems and ancillary equipment. The ramification of increased marine activities in the Arctic will be to stimulate more stringent ice-breaker vessel designs as well as ice-breaking cargo ships utilizing gas turbine engines. To support this increased northern activity more reliable methods of measuring ice forces on various vessel components must be developed along with the instrumentation required carry out the measurements.



Top:
Linked Combination - CCGS
Alexander Henry with ACT-
100 (Iceater I) attached
- Page 129.

Right:
CCGS "Wolfe" during trials to
test effectiveness of new bow
angle - Page 127.



CCGS "WOLFE" Icebreaker Bow Evaluation

Description

Previous research, which included model tests, has indicated that the icebreaking capability of the icebreaker CCGS "WOLFE" would be enhanced if the ship were fitted with a new bow which would decrease the waterline angle from 26° to 16°. Full scale trials were held before and after the refit (1969 and 1976 respectively) to verify the model test findings. The trial results to date have been inconclusive due to the highly subjective nature of reference points used to judge icebreaker effectiveness and to the limited data under various ice conditions that have been collected to date.

The current project is intended to add to the data in hand by continuing evaluation trials with the new bow in ice conditions not previously encountered. The specific objectives are to measure icebreaking forces in relation to ice thickness, ship speeds and propeller revolutions in sea ice and to investigate the effect of ice snow cover. Force measurements will be taken in the continuous icebreaking mode and deceleration measurements will be made for discontinuous icebreaking operations.

The results of these trials will be analyzed so as to compare the capability of the new bow with the old and thus verify the model test results.

Schedule

December 1975 - August 1977

Funding

\$52,000.

Recent Progress

Tests off Newfoundland were conducted in March. Two ice thicknesses (11" & 17") without snow were found suitable for testing. The ship was run at several speeds and power levels.

Project Number

6334

File Number

D 500-285-1

Contractor

Arctec Canada Ltd.

Reports

- Results of Full-Scale Trials in Ice of the CCGS Wolfe II, Arctec Canada Ltd. - December 1976.

Model Tests for Predicting Ice Forces Encountered by Propellers

Description	<p>A significant problem in Arctic operations is the high breakage rate of propellers and drive shafts due to ice forces. This breakage contributes not only to unreasonably high maintenance costs but also to disrupted schedules in an area where the operational season is already far too short.</p> <p>The intent of this project was to develop a mathematical model to use for predicting ice forces encountered by propellers. Forces exerted on small scale model propellers while milling artificial ice were measured and the results analysed to develop the mathematical model. The model is suitable for application in current and future propulsion equipment design activities for any vessel intended to operate in ice covered waters since it provides prediction equations for ice-milling loads on both fixed and variable pitch propellers.</p>
Schedule	June 1975 - April 1976
Funding	\$45,942.
Recent Progress	Project completed.
Project Number	5070
File Number	D 500-243
Contractor	Arctec Canada Ltd.
Reports	• Methods for Predicting Forces Encountered by Propellers during Interactions with Ice, Arctec Canada Ltd. - April 1976 (TP 293).

Air Cushion Vehicle Icebreaking Bow Development Program

Description

The air cushion vehicle used in this program was originally built, with government assistance, for Arctic Systems Limited, as a 100 ton capacity Arctic transporter. It was observed during winter testing in the Arctic that thick ice on rivers and lakes was broken as the transporter passed over it.

After preliminary model tests, TDC was charged with the task of organizing, managing and funding a multi-disciplinary development program to explore the technical, economic and commercial implications of the ACV's demonstrated icebreaking capability. The program (divided into two main phases) started with scale-model tests, theoretical analysis, and studies of economic feasibility and commercial impact and other proceeded to full scale operational tests.

For the first full-scale trials an air cushion platform was modified to fit the bow of CCGS "Alexander Henry". The trials were conducted off Thunder Bay during the winter of 1975-1976. Compared to her "normal" performance, the icebreaker with the ACV bow was not only able to break substantially thicker ice but did it while progressing at higher speeds, using much less fuel and leaving a better track for other ships to follow.

A second series of full-scale tests (Phase II) was planned for the winter of 1976-1977. The object of the tests was to demonstrate the commercial application of the air cushion platform, now known as Iceater II, and to accumulate additional data on the capability of Iceater II under operational conditions.

The technique used for the demonstration was to use a commercial tug or the CCGS "Griffon" to push the "Iceater II" to a vessel requiring a temporary icebreaking capability. During the trial the laker "Imperial St. Clair" was used as a typical example of such a vessel. The transfer of the platform from the delivery ship to its new host took less than an hour and the resulting progress of the St. Clair through ice was very satisfactory. In the course of delivering the "Iceater II" the CCGS "Griffon" maintained a speed of 7 knots through ice 32 inches thick.

Schedule	September 1975 - September 1977
Funding	Phase I - \$492,583. Phase II - \$362,213.
Recent Progress	Phase I - completed Phase II - completed.
Project Numbers	5097 - 6307
File Number	D 500-266
Contractors	Arctic Systems Ltd. (Major contractor) Arctec Canada Ltd. Marine Logistics Inc. Lakehead Harbour Commission Public Works Canada
Reports	<ul style="list-style-type: none"> • Results of Full-Scale Field Trials of ACT-100 with C.C.G.S. Alexander Henry, Arctec Canada Ltd. - October 1976 • Report of Full-Scale Icebreaking Tests of an Air Cushion Bow Platform Attached to the C.C.G.S. Alexander Henry, Thunder Bay, Ontario - Jan. to April 1976, Canadian Coast Guard, ACV Division • Model Tests in Support of Alexander Henry/ACT-100 Concept Development, Arctec Canada Ltd. - January 1977 • Economic Analysis of Application of Air Cushion Vehicle Technology to Icebreaking, CMTA/Marine Development and Planning - July 1976.

Analysis of Existing Model Ice Resistance Data

Description	<p>The amount of accumulated ice model data has increased greatly since 1971. However existing mathematical models used to predict icebreaking resistance do not give satisfactory results and input parameters are suspect.</p> <p>This project is intended to compile data currently available from model tests of 32 hull forms into consistent units so as to assess their reliability and enable regression analysis. A mathematical model will be produced which accurately corresponds to the observed results.</p>
Schedule	March 1977 - May 1977
Funding	\$15,515.
Recent Progress	Work is underway.
Project Number	6335
File Number	D 500-377
Contractor	Arctec Canada Ltd.
Reports	None available.

Analysis of Icebreaking by Air Cushion Platforms

Description

Current developments in ice-breaking technology requires that any analysis work done on the subject be given wide circulation. Two reports on the subject contain much significant information but are not in a format which could be useful or in some cases even understood by operational personnel. The current project is intended to review and synthesize the two reports. Emphasis will be given to data on vehicles moving at speeds below "hump" speed, that is below Froude 0.56 and critical reviews of the reports shall be taken into account. The reports to be synthesized are:

- "Mathematical Model of the Ice-Breaking Mechanism under a Slowly Moving Air Cushion Vehicle", D. Carter - 1975.
- "Mathematical Model of the Ice-Breaking Mechanism under an Air Cushion Vehicle Operating at or Near the Critical Velocity", D. Carter - 1975.

Schedule

February 1977 - May 1977

Funding

\$5,000.

Recent Progress

Work is underway.

Project Number

7405

File Number

D 500-266-11-3

Contractor

Dr. D. Carter

Reports

None to date.

Processing of Ice Data for Arctic Ice Atlas

Description	<p>Ice reconnaissance aircraft carry instruments which measure ice profiles and which record visual observations as to the number, age, class, and size of floes. This data have been accumulated for ten years in a raw form that requires manual processing and computer manipulation for inclusion in a Canadian Arctic Ice Atlas.</p> <p>The Ice Atlas will be of great value in assessing the difficulty of navigating in specific areas, the strategic planning of vessel movements and in the design of icebreakers, ice-reinforced ships, and fixed marine structures.</p> <p>This project is intended to fund the processing of the accumulated data so that the Ice Atlas can be published.</p>
Schedule	October 1976 - April 1977
Funding	\$43,000.
Recent Progress	Basic data processing was completed by students in 1976; preparation of text, maps, etc. of the Atlas is underway.
Project Number	6263
File Number	D 500-167-4
Contractor	Environment Canada
Reports	None to date.

Study of Ice Forces on Circular and Conical Structures

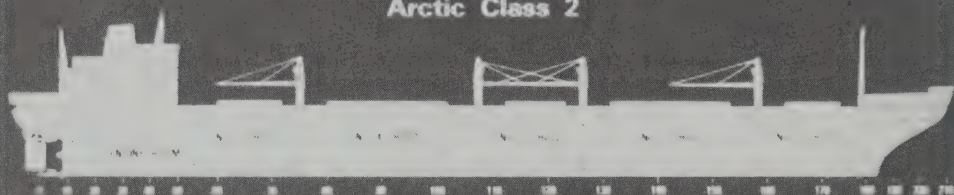
Description	<p>Recent developments in ice sheet analysis make it possible to predict the forces which inland water ice sheets exert on bottom founded offshore structures.</p> <p>This project is intended to develop the analytical methods necessary for these predictions as they apply to structures of cylindrical or conical shape. Researchers will corroborate the analytical results with field tests where possible.</p>
Schedule	January 1977 - April 1977
Funding	TDC - \$8,500. Coast Guard - \$10,000. Supply & Services - \$6,250.
Recent Progress	Work underway.
Project Number	6336
File Number	D 500-167-5
Contractor	F.G. Bercha & Associates Ltd.
Reports	None to date.

Study of UHF Radiometry for Remote Measurement of Sea Ice Thickness

Description	<p>A variety of remote sensing methods have been applied to ice reconnaissance, and it has been determined that only at ultra high frequency or lower, can radio frequency radiation significantly penetrate the volume or be emitted from the lower regions of sea ice. Preliminary work by Communications Canada and generally successful field trials indicated that a UHF radiometer might be a suitable instrument to measure ice thickness.</p> <p>Under contract with TDC, dual frequency radiometers were developed to observe automatically the brightness change phenomena which occur during the formation of ice sheets of various salinities; a test facility was constructed with instrumentation for direct measurement of the ice sheet characteristics.</p>
Schedule	September 1974 - August 1976
Funding	\$99,368.
Recent Progress	Project completed
Project Number	5005
File Number	D 500-230
Contractor	SED Systems Ltd.
Reports	<ul style="list-style-type: none">• Experimental Study of the Application of UHF Radiometry for the Remote Measurement of Sea Ice Thickness, SED Systems Ltd. - July 1976, (TP 254).

M.V. "ARCTIC"

Arctic Class 2



Deadweight - 28,200 long tons

Cargo Capacity - 1,208,000 cu. ft.

Length, overall - 607.50 ft.

Breadth - 75.25 ft. • Depth - 50.00 ft.

Deadweight Draft - 35.5 ft.

5 Hatches and Holds

Sea Speed and Fuel Consumption:

15 knots on 48 tons IFO 1500 sec. + 3 tons diesel

Special Features: Hull Air-Bubbler System • Helicopter Pad

"M.V. Arctic", a Canadian icebreaking bulk cargo vessel currently under construction at Port Weller Shipbuilding and Dry Dock Limited - Page 139.

Icebreaking Cargo Vessel "MV Arctic" Scientific Evaluation Program

Description

M.V. "Arctic" is a Canadian icebreaking bulk cargo vessel currently under construction at Port Weller Shipbuilding and Dry Dock Limited. She is designed to meet Arctic Ice Class II specifications, which indicates a moderate icebreaking capability in accordance with the Arctic Shipping Pollution Prevention Regulations. (ASPPR)

A three part instrumentation and evaluation program has been defined to fully exploit the potential for gaining experience in ship design and commercial Arctic operations. Part one, the instrumentation segment, is intended to develop the instrumentation and the methodology required to evaluate structural strength standards, correlate full-scale and model icebreaking measurements, evaluate of some special ship features, and record environmental conditions. The structural and environmental data are particularly relevant to evaluation of the corresponding parts of the ASPPR's.

The second part of the program will provide for operational evaluation and the collection of data over the five year period following delivery of the vessel.

The third part of the program, to be carried out simultaneously with the first and second parts, will address the development and testing of new instrumentation for use of the ship for Arctic marine environmental sensing and evaluation.

Schedule

February 1976 - December 1983

Funding

Part 1 - \$750,000.
Part 2 - \$875,000.
Part 3 - \$275,000.
Total: \$1,900,000.

Recent Progress

Ship instrumentation design inhand and ship under construction.

Project Number

6250

File Number

D 500-102-4

Contractor

Part 1 - German & Milne Marine Consultants.

Reports

None to date.

Assess Y-PASS Ship Propulsion System

Description	<p>Icebreakers function within constrained waterways and amidst floating and submerged ice flows that create hazards for the ships appendages, particularly propellers and rudders. A Y-shaped propulsion system Y-PASS has been developed and patented by Central Design and Drafting Ltd. of Montreal which appears to offer greater propeller protection and which also improves the maneuverability and increases bollard thrust when compared to conventional, or externally ducted propellers.</p> <p>The Y-PASS system consists of a "Y" shaped passage, with inflow water coming from either side of the hull and with a central outflow astern, enclosing both the propellers and the twin rudders of a shallow draft design vessel. Heavy bars at all openings prevent ingress of ice lumps or other material which may foul the screws. This project is intended to assess the Y-PASS system with respect to its ice worthiness and open water propulsive performance. This evaluation will be used to compare the Y-PASS system with more conventional systems.</p>
Schedule	March 1976 - June 1977
Funding	\$72,057.
Recent Progress	NRC testing of model is underway.
Project Number	5200
File Number	D 500-244-1
Contractors	Arctec Canada Ltd. Central Design and Drafting Ltd.
Reports	None to date.

Combined Steam & Gas Turbine Propulsion Plant

Description

Conservation of fuel in any operation is in keeping with current Canadian Government policy. Preliminary review by Pratt & Whitney Aircraft of Canada Ltd. of a concept which combines steam and gas turbine power packs with a marine propulsion system indicates a significant fuel saving coupled with a power increase over the gas turbine alone.

An improvement of 17.6 percent in power with a reduction of 22.7 percent in fuel consumption at that power is forecast.

This project is intended to address the thermodynamic efficiency improvement of large (40,000 to 50,000 SHP) marine gas turbine propulsion prime movers by combining in the cycle a heat recovery steam boiler and a supplemental steam turbine. Researchers will undertake the engineering investigations necessary to analyse, define and prepare specifications for such a system based on a realizable hardware configuration and operational duty cycle. The target application which will influence the size and characteristics of the system is large Arctic resource carriers which have an ice-breaking capability.

Schedule

October 1976 - November 1977

Funding

\$189,110.

Recent Progress

Program definition completed including a preliminary rough design, establishment of performance objectives, and a survey of potential market applications.

Project Number

6252

File Number

D 500-323

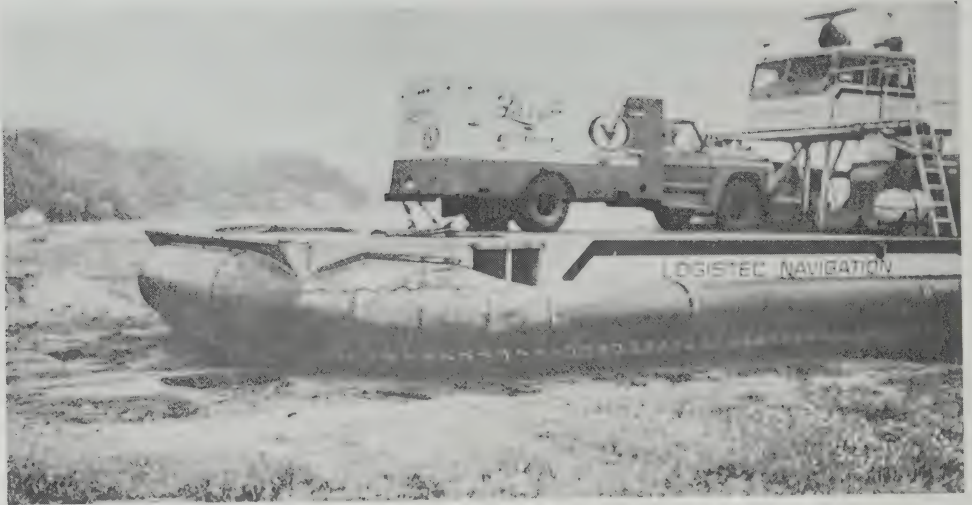
Contractor

Pratt & Whitney Aircraft of Canada Ltd.

Reports

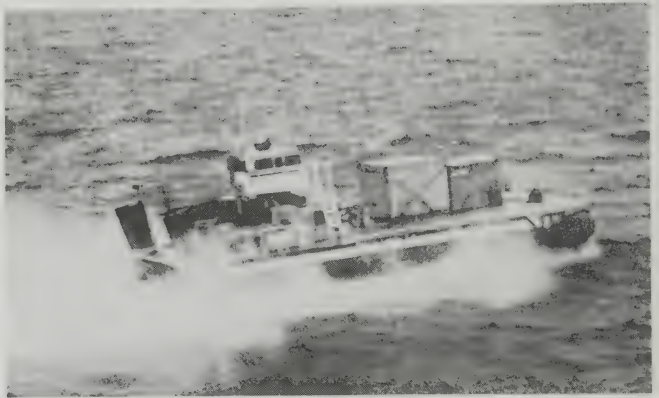
- Combined Cycle Gas Turbine Plant for Marine Propulsion Phase I, Program Definition, Pratt & Whitney Aircraft of Canada Ltd. - January 1977.

Marine Transportation Systems



Top:
Voyageur approaching loading
ramp to unload a truck during
Lower North Shore Demonstration. - Page 147.

Right:
Voyageur 004 underway with
deck cargo during demonstration
project. - Page 147.



Extension of Eastern Range for Upper Lakers

Description

Canadian Great Lakes vessels now use a coastal corridor in the Gulf of St. Lawrence leading as far east as Canso, N.S. for a limited period during the summer. TDC and the Province of Nova Scotia are jointly funding a study proposed by the Dominion Marine Association to examine the feasibility of extending the navigation period to coincide with the opening and closing dates for the St. Lawrence Seaway roughly from April to December.

To this end the structural strength of typical lake vessels will be considered together with Gulf wave data to assess the ability of the lake vessels to withstand the forces of the Gulf waters during the extended season. Computer analysis of this data should indicate either the suitability of the typical Great Lakes bulk carrier for late season operation or the degree of structural modification necessary for such operations.

Schedule

March 1977 - December 1977

Funding

TDC -	\$ 95,036.
Lloyd's -	\$ 50,000.
Province of Nova Scotia -	<u>\$ 25,000.</u>
Total -	<u>\$170,036.</u>

Recent Progress

Work underway.

Project Number

6356

File Number

D 500-373

Contractor

Dominion Marine Association.

Reports

None to date.

Study of Shipping Options for Canadian International Deep Sea Trade

Description

The objective of this study is to quantify direct commercial benefits and costs which would accrue to the Canadian economy from the carriage of three specific types of cargo, in selected commodity trades, so that these costs and benefits may be compared under the following options:

- Foreign shipping services
- Canadian managed and operated foreign flag ships
- Canadian managed and operated Canadian flag ships with vessels being purchased from the cheapest sources of supply
- Canadian built, managed and operated Canadian flag ships.

Seven study elements comprehensively cover pertinent aspects of the Canadian and international shipping scene and comprise two phases of the study. The program is broken down into three phases. The first was intended to review and assess the present status of Canadian International shipping, with quantitative identification of commodity routes, representative vessel characteristics, and Canadian use of foreign flags.

The four options were identified and a sensitivity analysis carried out to determine their effect on transportation costs.

The last phase determined the direct commercial benefits and costs accruing to the Canadian Economy for each option, together with an evaluation of any assistance necessary to make Canadian vessels competitive.

Schedule

October 1975 - May 1977

Funding

\$334,300.

Recent Progress

Final report being assembled

Project Number

5095, 5103

File Number

D 500-264

Contractor

Alcan Shipping Services Ltd.
Sores Inc.

Reports

None to date.

Voyageur Air Cushion Vehicle Lower North Shore Demonstration Program

Description

The basic demonstration involved the use of a "Voyageur" air cushion vehicle to serve the small, remote communities in the Middle and Lower North Shore of the St. Lawrence, and covered the winter season when ice and weather conditions are so severe that seaborne freight delivery often is not possible. Social, technical, and economic objectives of the program were achieved by demonstrating and evaluating the capability, degree of reliability, and cost factors in providing regular commercial operation schedules. The Voyageur ACV operated to a variety of landing sites in a harsh environment and carried several types of cargo into areas not readily accessible in any other economical way.

In addition to "point to point" operations, the ACV was used as a lighter to deliver freighter cargo to communities inaccessible to the ship. This demonstrated a unique integration of an ACV into an existing system to the benefit of all. Cost per ton of delivering cargo by lighterage was less than 20% of that by point-to-point methods.

An unexpected requirement for a truck ferry service provided an unusual opportunity to demonstrate the flexibility of the ACV. It not only provided the service required but was also used to find satisfactory landing sites for the trucks.

Criteria for remote area operation, related to supply of maintenance requirements, effective quality assurance of craft, equipment, fuel, etc., were established and should be invaluable to any future operation.

Schedule

September 1974 - March 1976

Funding

TDC -	\$388,836
Prov. Que. -	\$310,036.
Agence Maritime Inc. -	\$ 20,000.
Total -	<u>\$718,072.</u>

Recent Progress

Project completed.

Project Number

5035/5036

File Number

D 500-196

Contractor

Agence Maritime Inc.
German & Milne Consultants

Reports

- Voyageur Air Cushion Vehicle - Lower North Shore Demonstration Program Final Report, Transportation Development Agency - March 1976, T48-11/1976

- Analysis of a Voyageur Transportation System Along the St. Lawrence River Lower North Shore, Bell Aerospace Canada, Report No. 7380-927015 - September 1973
- Voyageur Trials, Phase I, 1972, D.O. Dutfield, ACV Division, Ministry of Transport - March 1973
- Voyageur Trials, Phase II, 1973, D.O. Dutfield, ACV Division, Ministry of Transport - November 1973
- Voyageur Air Cushion Vehicle Lower North Shore Demonstration Program, Report I: Craft Deployment, Bell Aerospace Canada, Report No. 7380-927010 - November 1974
- Voyageur Air Cushion Vehicle Lower North Shore Demonstration Program, Report II: Cargo Deliveries, Point-To-Point, Bell Aerospace Canada, Report No. 7380-927020 - March 1975.
- Voyageur Air Cushion Vehicle Lower North Shore Demonstration Program, Report III: Cargo Deliveries, Point-To-Point and Lighterage, N.I. Safeer, Bell Aerospace Canada, Report No. 7380-927021 - May 1975.
- Voyageur Air Cushion Vehicle Lower North Shore Demonstration Program, Report IV: Cargo Deliveries Using a Feeder Service and a Truck Ferry Operation, N.I. Safeer, Bell Aerospace Canada, Report No. 7380-927022 - July 1975.
- Effects of the Hovercraft on the Social Life of the North Shore Winter 1974-1975, R. Bruneau, Quebec Department of Transport, Communications Branch - June 1975.
- Bell Voyageur 002 ACV - Cold Weather Evaluation, Transportation Development Agency - August 1974.
- Bell Voyageur 002 ACV - Engineering and Commercial Evaluation, Transportation Development Agency - June 1975.
- Bell Voyageur 002 ACV - Environmental Assessment, Transportation Development Agency - July 1975.
- Bell Voyageur 002 ACV - Summary of Evaluation Program, Transportation Development Agency - December 1975.



Top:
 Illumination cast from High
 Intensity Light Source during
 approach to Seaway lock at
 Beauharnois, Quebec
 - Page 151.

Right:
 Illumination of approach to
 Beauharnois lock, Quebec
 during demonstration of
 HILS - Page 151.



High Intensity Plasma Light Source for Marine Transportation Applications

Description	<p>The high intensity plasma lamp seems capable of satisfying a marine requirement for a powerful, compact light source for use in a number of specialize applications such as icebreaking operations, search and rescue, and night time clean-up of oil spills. An experimental plasma light source has been developed by the RCA Canada Limited laboratories under contract with the Canadian Defence Research Board. It has an overall efficiency of 40 percent and is capable of providing approximately 60KW of useful radiated power. The lamp head (including reflector) measures 20''w x 18''h x 12'' depth and weighs about 150 pounds. The lamp head can be separated up to several hundred feet from the power supply and is suitable for mounting on the mast of the ship. This type of light source also has potential for application in other modes of transport and for other commercial purposes such as stadium lighting.</p> <p>This TDC project will develop and demonstrate a prototype 60KW high intensity plasma light source for marine transport applications. Improvements will be made to the present experimental design to increase the efficiency of the unit, reduce the weight of the power supply, and to provide better portability and reliability. Extensive tests of the prototype light source will be undertaken under actual operating conditions on board a Canadian Coast Guard icebreaker.</p>
Schedule	January 1977 - June 1977
Funding	<p>TDC - \$145,300.</p> <p>Coast Guard is contributing personnel to the project and providing a ship for the tests.</p>
Recent Progress	<p>A successful demonstration of the experimental plasma light source was made aboard CCGS "Norman McLeod Rogers". Construction of the improved prototype model is underway.</p>
Project Number	6278
File Number	D 500-360
Contractor	MPB Technologies Inc.
Reports	None to date.

Survey of Ship Fender Research

Description	<p>Conventional fenders and mooring lines securing large ships form a massive elastic system which, with input from wave action, can develop a bouncing effect. Extremely high tensions may be developed, particularly if a resonant condition occurs between water forces and the ship-plus-moorings combination.</p> <p>The concept of a marine fender with an energy dissipating characteristic appears to offer significant potential for reducing ship motions and mooring line forces.</p> <p>The intent of this project was to survey some 50 laboratories to determine which facility might be best able to address the mooring line tension problem.</p>
Schedule	October 1975 - August 1976
Funding	\$4,973.
Recent Progress	Project completed.
Project Number	5100
File Number	D 500-163-2
Contractor	Lasalle Hydraulic Laboratory Ltd.
Reports	<ul style="list-style-type: none">• Survey of Hydraulic Laboratory Research into Performance of Ship Fenders with Asymmetric Energy Transfer Characteristics, Lasalle Hydraulic Laboratory Ltd. - August 1976.

Appendix A

The Transport Canada Research and Development Centre (TDC) was formed to identify, promote and manage the application of science and technology to transportation. TDC provides research and development support to the components of Transport Canada which require specific data and research and demonstration projects to assist their operational, regulatory, policy, planning and evaluation activities. It also undertakes discretionary research and development addressing requirements that are national and long range in scope.

TDC evolved from the former Transportation Development Agency which was created in 1970 to support the Ministry of Transport then-stated objective for the development of transportation in Canada:

“To encourage and promote continuous improvement, innovation, growth or phase-out of modal and inter-modal transportation”.

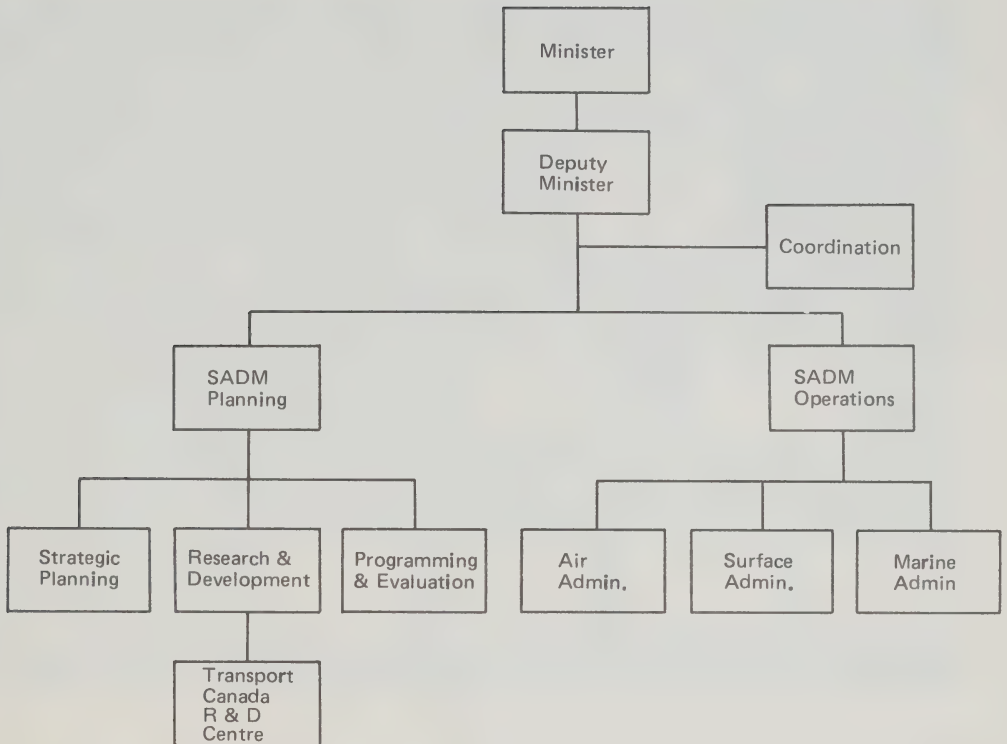
TDC is located in Montreal, which facilitates its interaction with the head offices of the majority of Canada's major transportation operators and suppliers. In addition to industry, TDC is involved with universities, consultants, other governments and the far-reaching transportation environments in Canada and around the world. Its purview covers all modes of transportation and its activities range from conceptual research through design, prototype testing and development to the revenue demonstration stage. TDC's projects cover improvements and modifications to existing systems as well as research and development on advanced systems and components not yet in operational deployment. The work is undertaken on a project basis primarily through contracts with appropriate Canadian organizations and also through in-house studies. TDC administers a university fellowship and grants program whereby support is available to post-graduate students and selected university centres specializing in transportation studies.

As shown on the accompanying Transport Canada organization chart (Appendix B), TDC reports to the Assistant Deputy Minister, Research and Development (ADMRD). His function is to co-ordinate the research and development undertaken by the various components of Transport Canada as well as be cognizant of all transportation related research and development within the Federal Government. ADMRD is supported in his function by the Research and Development Sub-Committee of the Transport Canada Programming Committee (which endorses Transport Canada's program plans). On a Government-wide basis, his membership in the Inter-Departmental Committee on Transportation Research and Development ensures that there is liaison regarding all

transportation related research and development underway. Inputs for long range planning and setting of research and development priorities are received through membership in a number of committees and advisory boards, such as: The Railway Advisory Committee, the Marine Research and Development Committee, the USA/Canada Memorandum of Understanding on Research Cooperation in Transportation, the Science and Technology Agreement with West Germany and many others. Through a variety of activities and membership, TDC and ADMRD staff keep abreast with national programs where there is a transportation interest. Such programs are those of the Federal Energy Panel, urban development, environmental quality, Regional Economic Expansion, The Canadian Organization for the Simplification of Trade Procedures (COSTPRO), the science "make or buy" policy of the Ministry of State for Science and Technology and the Enterprise Development Program of Industry, Trade and Commerce.

TDC consists of the Technology Branch and an Administrative Services Group that services not only the three divisions of the Technology Branch (Current Technology, Advanced Technology and Technology Applications), but also three lodger units: The Strategic Studies Branch of Transport Canada's Strategic Planning Group; the Urban Transportation Research Branch of the Surface Administration and COSTPRO. The lodger units share with TDC the facilities, library and services located in Montreal but are autonomous from TDC regarding their purview, accountability and reporting relationships (as shown on Appendix C).

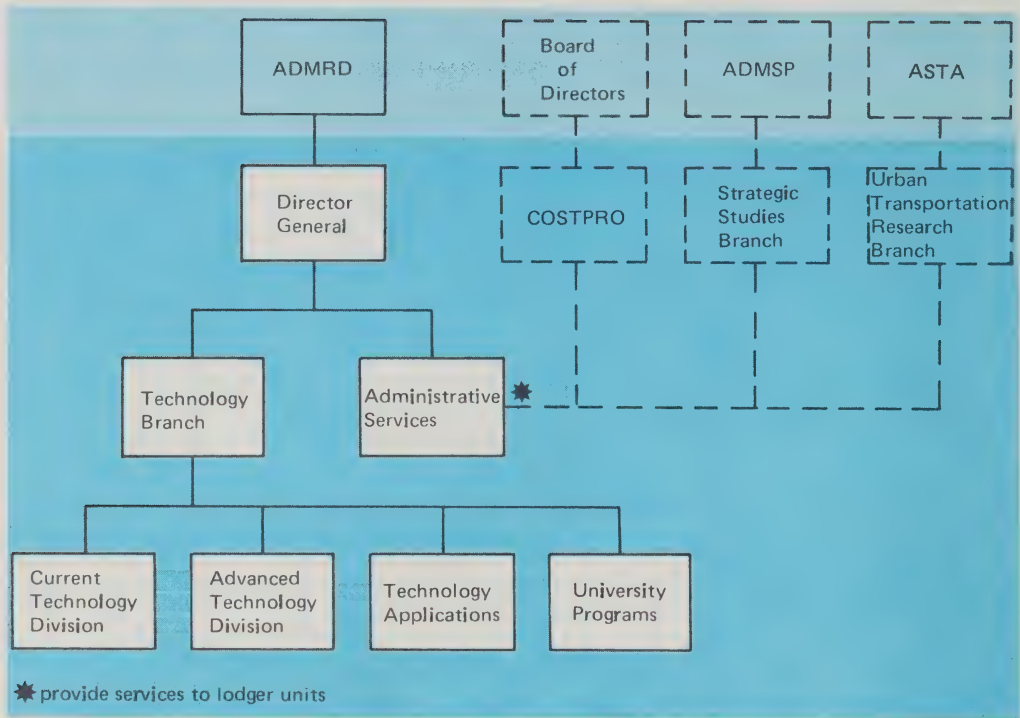
Appendix B — Transport Canada General Organization



SADM - Sr. Assist Deputy Minister

Rev. 7/8/77

Appendix C — Research and Development Organization



- Transport Canada Research & Development Centre
- Ottawa
- Montreal

ADM RD - Assist. Deputy Minister Research & Development
ADMSP - Assist. Deputy Minister Strategic Planning
ASTA - Administrator Surface Transportation Administration

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